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THE

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ELECTRIC TRACTION AT THE MECHANICAL ENGINEERS.

EVEN a lapse of three months since the adjournment of the discussion upon Mr. Philip Dawson's paper before the Institution of Mechanical Engineers has not proved sufficient to cool down the thirst of some English engineers and manufacturers for Mr. Dawson's blood, in consequence of what was considered on his part undue advocacy of American traction methods; and more than one of the speakers at the renewed discussion felt obliged to put in a few good words for the paper and its author, as being worthy of more praise than censure.

Probably if more real and unbiased experts in this field had joined in the discussion, it would have been clear that, as often happens, both sides were right and both were wrong; the fault with each lay in too hasty and comprehensive a generalisation.

We ourselves have been accused in more than one quarter of advocating the use of American designs and plant in electric traction work on this side; whereas, what we have always said, and what we still maintain is, that we do not need to go to the United States (in spite of the valuable and long experience they have had over there) for steam engines, dynamos, generators, boilers, tramcar bodies, switch gear, trolley wire, or numerous other essentials to an electric tramway; but when it comes to motors and controllers, as well as a series of designs for car trucks capable of enduring the severe work entailed upon motor cars, purchasers on this side may well pause before deciding upon home-made articles turned out by makers without a tithe of the experience possessed by Americans, who have gone through the costly mill of "trial and error." Moreover, these latter items are now being made in the States in such large quantities—at a low price even allowing for freight, and of high efficiency—that English makers cannot hope to compete in this direction for some time with any great measure of success.

While, therefore, the members of the Institution who joined in the debate, may have been right in criticising Mr. Dawson's advocacy of things American as of far too sweeping a character, they might with advantage be reminded that we have not as yet, in this country, surpassed, or even equalled, American methods and appliances of all kinds.

In regard to the question of engine types suitable for traction, there seems but little need to add any words to the remarks made by Mr. Mark Robinson. It is ludicrous to specify for a governor that shall govern an engine, and an engine that shall be governed, to within less than 1 per cent. of the normal engine speed. It is not as though the cars must be, or are, run with an unvarying pressure: with lighting it is different—a slight variation in engine speed tells at once upon the lights—but who knows of it when the line voltage of a tramway varies 40 or 50 volts in 500, or what practical difference does it make to the service? The cars at the end of a long line may slow off a little, but the

variation is only momentary, and cannot have any serious sustained effect.

So long as an engine is not overloaded, and has automatic expansion gear, with a governor to prevent racing, it ought to work perfectly well, and the particular decimal fraction of 1 per cent. variation in speed is not worth troubling about. Even if it were, we have plenty of engine builders in this country who can turn out engines equal to, if not better, than the American-made articles, and with as good, if not better, governing powers.

Turning to one other point which cropped up rather prominently at this discussion, it may be worth while emphasising again the real reason for the want of progress in electric traction here as compared with America. One speaker seemed to think that the reason was because we have much better roads than are usual in the States; but if so, have we a greater number of public road vehicles, such as omnibuses? Certainly not, and, therefore, his argument falls to the ground at once. As a matter of fact, the average passenger-car-mileage density is, we believe, greater in this country than in the States, so that such tramways as we have are as much used in proportion as are those in America.

The true reason for greater development across the Atlantic is obviously that which other speakers insisted upon, viz., the absence of absurd legislation and official restrictions, such as those embodied in the Tramways Act of 1870, the title of which offers the choicest piece of sarcasm we ever remember to have seen:—An Act to *facilitate*, &c., the construction, &c., of tramways!! In driving this truth home, Sir Frederick Bramwell appears to have spoken at the meeting with his official muzzle removed; and the fact is worth noting that the same official referee called in to adjudicate upon the value of a tramway, &c., under the Tramways Act, should, when speaking as a private individual, criticise so strongly the results of the very Act he has practically been called upon to administer.

A strong contrast is noticeable between the remarks of practical men like Mr. Robinson, who dealt only with the points they specially understood, or were qualified to discuss, and the more or less vague and general utterances of the "professors." Why, for instance, should a man of so high a capacity as Prof. Unwin advocate the use of conduit lines instead of the trolley, and mention as an argument that 200 horses had been killed in Boston? Surely he knows the enormous cost of a conduit line, and that if one is being put down in New York, many others (in the shape of cable roads) elsewhere are being replaced by the trolley. There is only one New York, and the conditions of tramway work there are almost unique, just as they are in London. As for the horses, if a blizzard *will* persist in coming every few years, breaking down wires of every sort, it certainly seems wiser to employ a trolley system that can be easily repaired, and is usually less liable to stoppage, than a conduit line, even at the risk of shocking a few horses to death. It takes precious little current, anyway, to kill a horse, and if public convenience is preferred the horses must either go off the streets altogether or take the risk. The average horse would, we think, prefer to take the one-in-a-million chance of being shocked to death rather than the one-in-a-hundred chance of being worked to death on a tramway in a couple of years.

In concluding this notice of the discussion, a word of admiration ought to be put forward in regard to the persistence with which the subject of bicycle-wheel fly-wheels is introduced by the inventor or deviser. Should a paper be announced for any of the Institutions wherein there is the least reference to a fly-wheel, so surely does that familiar diagram appear on the wall or the blackboard, accompanied by figures and formulæ sufficient for two ordinary college lectures. Mr. Dick was always very fond of introducing King Charles's head into conversations not always connected therewith. The inventor of tangential fly-wheel spokes had more excuse for bringing up his pet subject at the Institution discussion, and he made the most of it. There is much to be said for his device, when the old-fashioned forms of fly-wheel are considered; but Mr. Robinson knocked a good deal of ground from under the feet of this idea (if it can be said to have any) by showing that the disc form of fly-wheel, with small diameter, is quite good enough with high-speed, short-stroke engines.

We shall await Mr. Dawson's written reply to the discussion with interest. He has, at any rate, plenty of points to deal with.

Storage Battery Traction.

Some time ago we commented upon the Englewood-Chicago storage battery line, giving particulars of the power house, plant, &c., when equipment was going on, and anticipating further information after actual work had begun. Tests—of a rather qualified nature, so far as their practical value is concerned—have lately been made on the generating plant and batteries, and the figures derived therefrom are to be found in another part of this issue of the Electrical Review. So far as the engine house plant is concerned, with coal at 7s. 8d. per ton (giving 10,145 B.T.U. per lb.) the net cost of fuel per kilowatt-hour at the switchboard was about ·305 of a penny. The batteries gave an apparent energy efficiency of 60 per cent., but quite an insufficient series of charges and discharges are taken for this result, and we imagine it to be the case (as we expected) that at least a year's working must be taken before any effort can be made to get at the exact state of affairs in battery working. By the end of that time the balance-sheet ought to be as good a test as any of the possibility of using battery traction with reasonable hope of success from an economical standpoint. As a rule it is an all sufficient test, but there has been in time past too great a tendency to bolster up storage battery traction by the manufacturing interests engaged, irrespective of absolute results. The battery cars appear to have required 1·41 units per car mile at the charging table, and about ·87 unit per car mile at the motors, equal to 10 lbs. of coal per car mile. The difference, ·54 unit, represents the loss per car mile in the battery. We shall not be at all surprised if further experience shows this loss to be continually greater as the battery deteriorates with use. No figures are given as to the cost of labour or maintenance, so that final judgment in regard to this instance of a storage battery worked line must still remain suspended. The line is evidently of a very level nature, otherwise we should expect motor cars weighing nearly 12 tons when fully equipped would require a considerably greater consumption of energy per car mile than that above named.

Post Office Telegraphs.—The Postmaster-General has appointed Mr. Edward May to the Controllership of the Central Telegraph Office rendered vacant by the retirement of Mr. H. C. Fischer, C.M.G. Mr. Thomas Barlow will succeed Mr. May as Deputy Controller.

ENGLEWOOD AND CHICAGO ELECTRIC STORAGE BATTERY ROAD.*

Ever since the consolidation of storage battery interests in this country, electrical engineers have looked forward with a feeling of satisfaction and vindication to the time when the storage battery would displace the uncomely overhead and expensive underground trolley. The problems which had up to that time occupied the minds of a few investigators, were now being attacked by numerous inventors desirous of producing a light weight accumulator, one which would not deteriorate rapidly, and a generally practical system of handling storage roads.

While these questions received the closest attention of electrical engineers, the steam generating and transmitting, as well as electrical machinery, were being marvellously developed. But while we heard of storage batteries performing many useful functions in central stations, the only roads worthy of mention whose cars were equipped with accumulators, were those of Berlin, Paris, Vienna and Birmingham. On the other hand, the Metropolitan Railway Company of New York, after a thorough investigation of all existing methods of street car propulsion, adopted the electric conduit system over a large network of thoroughfares.

We have watched, meantime, in conjunction with everyone interested in electric traction, ever since its inception in 1895, the progress and success of the Englewood and Chicago electric storage battery road, and now that the results of carefully executed efficiency tests have been made available, we take pleasure in presenting below some of the results and conclusions of these tests to our readers. During last summer over 20 motor cars were operated, often with trailers, and thousands of people were carried each day. The tests were conducted under actual operating conditions, no effort being made to obtain results better than might be expected in everyday service. The engines developed a total of 232 72 horse-power; the electrical output was 186 9 horse-power, showing an efficiency of 80 per cent., the average all-day efficiency being 79·3 per cent. The log of the boiler tests shows that the steam pressure was 168·3 lbs., and that 8·22 lbs. of water were evaporated per pound of combustible from and at 212° F., and that the boilers developed 149 horse-power each; 62 86 per cent. of the total calorific power of the fuel was utilised. The results of the tests on engines, dynamos and auxiliaries show that 18 lbs. of dry steam were used by each engine per indicated horse-power hour. The average output of each generator was 128·3 kilowatt, which was 67·5 per cent. of full load. The load factor was ·82, and the watt hours per pound of coal 155·2. The cost of coal was $1.90 per ton, and its cost per net kilowatt hour ·611 of a cent. The conditions of the test were not favourable, however, as the steam pressure was lower than it should have been and the vacuum was only 24·25 inches. The engines were also overloaded during the entire run and were not operated at their rated speed. The average percentage between the horse-power developed in the cylinders and the electrical horse-power delivered on the switchboard is shown to be 79·27 per cent., which is very satisfactory, and the efficiency of the generators (running 32 per cent. below their rated capacity) is 93·1 per cent. The total station efficiency from coal pile to switchboard is 5·58 per cent. As a matter of comparison we may state that the efficiency of the Chicago Edison Company's Harrison Street station, producing electrical energy for ·3 of a cent. per kilowatt hour, is only 4·61 per cent.

To make a fair test of the batteries, 110 trips were made on one day and 123 trips on another, giving a total of nearly 3,500 car miles. The results of these tests show the following:

Kilowatt hours at switchboard per car mile, 1·37 and 1·63 for the two days, respectively; pounds of coal per car mile, 9·45 and 10·50; cost of coal per net kilowatt hour, ·655 and ·611 of a cent; cost of coal per car mile, ·897 and ·966 of a cent. It should be remarked that there was a coating of ice upon the rails during the latter part of the second day. The total number of stops during four trips was 57, and the average speed of the cars was 11·84 miles per hour.

* New York *Electrical Engineer*.

Two efficiency tests of the battery give results of 53·6 per cent. and 62·32 per cent., respectively. These results, however, show the efficiency in actual service, but do not represent the possibilities of the batteries. All these results have been carefully plotted in the form of curves, including acceleration and current curves.

While the figures given are very gratifying, it should be stated that the tests do not demonstrate the best results that may be expected of storage battery traction, and were not made for that purpose. The primary object of the test was to determine where improvements could be made, and if this is kept in mind when comparing the results with those obtained on a trolley system of about the same size, it will be seen that the cost of fuel for accumulator traction of something less than one cent per car mile is very favourable to storage battery traction. After the improvements suggested by the tests have been made, and better coal than was used on the test, at a cheaper price, has been secured, the fuel cost per car mile should be brought well within one-half cent. The batteries have operated from 8,000 to 14,000 miles and are standing the service remarkably well, so that the maintenance account up to the present has been comparatively small.

The tests were in charge of Mr. George A. Damon, consulting engineer, who was ably assisted by Prof. T. P. Gaylord and a corps of students from the Armour Institute of Chicago. In conclusion we venture to express the opinion that the experience gained by the enterprising Englewood and Chicago Street Railway Company will benefit all interested and engaged in electric street railway development, and that it will lead to further improvements in accumulators, and the more extensive introduction of storage battery traction in the United States.

THE VENTILATION OF THE METROPOLITAN RAILWAY TUNNELS.

We are in receipt of a pamphlet from Mr. Robert Cox, M.P., on the above subject. It appears to have been compiled by Mr. Ernest Callard, of the London Chamber of Commerce, and to be essentially the evidence before the Board of Trade Committee of Inquiry of Mr. Jas. Keith. Mr. Keith practically confines himself to positive fan ventilation by means of slow running fans placed midway of the stations, and we are glad to see that an absence of sulphurous smoke from the tunnels of the South London electric lines is not allowed by Mr. Keith to stand for ventilation.

The Metropolitan Railway may be foul with sulphurous fumes, but it is probably little worse than the South London line, which has not the advantage of germicide smoke to disinfect it. We do not believe in this purification of tunnels by choking fumes of sulphur, but an electrical line ought not to be put down without any attempt at ventilation. Mr. Callard shows that the Metropolitan Company hold their powers under their Act of 1854, which gives them full power to use any sort of motive power they like to employ, *without any approach to Parliament for further powers*. This being so, he questions the honesty of the company in procuring the insertion of inspired paragraphs in the press that they are seeking Parliamentary powers to adopt electric traction. All this is to beguile the public; as to which, however, there may be two opinions, as we shall show later.

It is certain that electric traction would prove a fair cure for the Metropolitan fumes. Being so near the surface, there would always be a change of air at the blow-holes sufficient to purify the tunnels of the only then possible pollution due to the presence of a certain number of people passing through.

The deeper-buried electric line in South London cannot purify itself, and is not even arranged, as it has been claimed to be arranged, so that the trains will assist ventilation. The trains churn the air, they do not push much out. Yet they might easily have been made to do so, and the otherwise necessary fans avoided. Any mining engineer would have shown how to ventilate the South London tunnels by

the aid of a few brattices. As it stands, this line is but poor testimony to the boasted purity of electric traction.

It is worth note that on the Metropolitan line, at Gower Street platform, Dr. Haldane found 89·4 parts of CO_2 per 10,000, or over 22 fold the atmospheric normal. The committee would draw the maximum limit at 15 to 20 parts. As to the beguiling of the public by asking powers from Parliament, there is another side to the question. The company may have the legal right to use any motive power they wish to use, but rights are of little use unless supplemented by financial ability, and it is the financial ability which we understand is the real object of the Bill. Money is required to equip a railway for electric traction, and when this has been done, it will be time enough to apply mechanical ventilation, if such is needed. We do not believe it will be needed. In a shallow buried railway, the movement of the trains and the natural current caused by wind pressure acting at the open stations will probably be ample to keep pure the tunnels when these are free of the locomotive products. Such means, however, are quite inadequate to deal with deeply buried lines. At one time there was a good deal of nonsense written about piston trains, which would clear out the tunnels in front of them, and draw in fresh air behind them. As carried out with each tunnel opening into the same station at each end, the piston effect has resolved itself into a mere horizontal circulation of air from south to north by the up tunnel, and back again by the down tunnel to the south. There has been no serious attempt to let in fresh air from the surface, and to expel foul air to the surface, by any systematic piston effect of the trains. The thing is feasible enough, no doubt, and if not feasible, it ought not to have been seriously advanced. These deep tunnels are multiplying all over London, and they will have to be ventilated in some way. In the report before us, a Mr. Morrison is quoted to the effect that 1 lb. of coal burned is equivalent to the pollution of a tunnel by 500 people. This is an entirely wrong view. The amount of carbonic acid gas produced may be equivalent, but so is the amount of this gas produced from an ounce of graphite and an ounce of diamonds. The latter equivalence no more determines the market price of diamonds and of graphite than does the former measure the real pollution. It is not so much the presence of CO_2 that is harmful as the toxic poisons, the wasted organic tissues, the organic nitrogenous substances—in short, "the rich steams of sweet humanity" so ably discoursed of by Mokanna. These are what render the South London line so objectionable, and what future lines should have a care to eliminate.

MORE THIRD RAIL SYSTEMS.

It is most surprising to see the frequency with which American inventors make efforts to improve upon the details of some well known principle, where an English engineer would rather break fresh ground altogether and try absolutely new methods instead of changing parts of a mechanism.

Thus, in a recent number of the *Electrical World*, were described and illustrated a couple of so-called "third rail systems," both of which have evidently had a considerable amount of trouble and ingenuity spent upon them by their devisers, but which may safely be classed amongst the "might-have-beens." To our mind it seems really a waste of time to spend even a single hour upon working out such devices so long as the simple third rail and overhead trolley wire systems remain feasible for ordinary working conditions.

The first of the devices under notice claims to be especially suitable for elevated and suburban railways usually worked by steam. It consists of a sectional third rail with alternating live and dead portions, the mechanism for throwing over the switch contact arrangement (sending current into each live section) being actuated by frictional end pressure due to the contact shoe upon each separate section of the third rail, which has a slight amount of end play.

The only advantage of such a device is that the current is kept from an exposed rail conductor except on such portions as are covered by the car or train, and presumably this is considered to be worth the extra cost and complication of the system. But the only persons to consider (in this country at least), so far as freedom from shock is concerned, are the railroad employés who are naturally supposed to know the dangers of their work and take precautions accordingly. There is no great economy of current in keeping it within a feeder, save only on the portions of line under the trains themselves: usually the third rail itself is feeder and conductor rolled into one.

The working details of the device are, however, developed in a most ingenious way, and make one wonder what the inventor might not do if he were to attempt a contrivance on absolutely new lines.

The other device is also characterised by novelty and ingenuity. It is intended for use with a third rail in street tramway work, and embodies the use of a small set of storage batteries and a motor generator on the car of sufficient size (but obviously quite small) to actuate the magnetic switches generally employed for throwing current into the third rail sections, one after the other. This motor generator is wound to take a small current from the battery at 10 volts and convert it into a 500-volt current, so that the third rail and rail return may be introduced directly into the magnetic switch circuit.

The third rail sections are alternately live and dead, the former as a rule about 8 feet long, the latter 6 feet. With two shoes upon each car there is always one live section in circuit.

This device may also be considered well worked out in detail, but the surface contact system for street tramways has, in any case, but little chance of general adoption, even in the towns and cities of this country where some amount of prejudice exists against overhead wires.

STEAM ENGINE MECHANICAL EFFICIENCY.

A correspondence is going on in *Engineering* anent an expression of opinion by Mr. Raworth that there would be a loss of only 15 per cent. between indicated and electrical horse-power in a cotton mill, as compared with a loss of 40 per cent. between cylinder and crank-shaft in the present arrangement. Mr. Herschmann corrects the writer, and points out that Mr. Raworth's figures had reference to the waste between the cylinder and the driven shafts of the machines. Nevertheless he is sceptical of Mr. Raworth's 15 per cent. for electricity. This correspondent rightly states that the cotton spinner is in a position to use large engines of an economical kind, and that in cotton mill driving, power is taken fairly direct to machinery, and that machinery may be classed as grouped, and properly looked upon as suitable for driving from shafting. The speed of motors also is too high for direct connection to machine shafts, and generally it is concluded that cotton mill driving does not afford the best field for electricity.

There is a good deal in what this correspondent says. A cotton mill is not a large cube through which a horse-power of 1,000 or 1,200 indicated is required to be distributed. Driving is very direct from the engine fly-wheel to the line-shafts. As compared with the losses in the ropes and shafts, there would be the loss at the dynamo, in the leads, and at the motors, and it is not as though there were any particularly long pieces of shafting. It is certain that at present a mill-owner would think twice before buying electricity; he might make his own, and use electrical transmission. But in a cotton mill there is never a considerable percentage of machinery standing idle. Almost everything in a cotton mill is paid for at piece rates, and while machinery is largely self-stopping, the attendants are particularly quick to set them going again when the "ends" are pieced up. Even supposing that electricity could be cheaply purchased, there remains the question of heating. Throughout the year some heating is necessary, or may be any morning. In winter it is a *sine quâ non*.

There must be steam boilers for this alone, and this fact would always help out the generation of power on the spot. The importance of reducing frictional losses to a minimum is rendered very evident in cotton mill practice. The product of a cotton mill contains very little energy—at most that represented by the torsion put upon the fibres twisted at an

exceedingly small moment of resistance. A large mill probably turns out about 1,000,000 miles of single yarn every week, containing about 1,250,000 millions of twists, which has been estimated to require, at the outside, 60 foot pounds of work per minute, or about $\frac{1}{500}$th of a horse-power. To secure this small end demands, say, 1,200 indicated horse-power, all of which disappears as friction and reappears as heat. A running mill soon warms itself to an intolerable degree in summer-time, and windows are opened.

There are those who probably hope to see electrical motors still more sub-divided than as at present. The ultimate divisibility would come in where every spindle had its own little motor; but it is not in the spindle driving that power is lost: it is in revolving the several rows of heavily weighted rollers, badly lubricated, that power is absorbed, to an extent compared with which the few lines of well-attended shafting are a small item.

As in most machinery, not much is known as to the power requisite to turn cotton machinery. The total work per spindle may be known, but we cannot learn of a roving frame being dynamometered when running complete and also with the rollers at rest, or of a spinning frame being measured for power absorbtion when run empty and when full. The difference goes into the drawing and twisting of the yarn, and is a mere nothing.

But to return to Mr. Herschmann, if the cotton spinner can himself generate a horse-power for 2 lbs. of coal, he becomes a difficult customer to deal with by an electrical company, even if this company generate with only 1½ lbs. of fuel. For electrical driving of factories the cotton mill, in fact, is one of the worst cases to deal with, and the large and widely-scattered workshops and tools of the ship yard or engineers' shop with occasionally worked heavy tools, stand as examples favourable to electricity.

THE BURNING QUESTION.

Our article under this heading on February 4th, concluded with the remark that we considered the cost of labour per ton of refuse burned, in relation to the wages paid, and the number of hours worked by the men, the most important element in the destructor question. This by no means removes the necessity of fulfilling the other conditions which we mentioned, viz., that nuisance from dust or smoke must not occur, that the refuse should be completely burned, and that the temperature should be maintained as high as possible. But as we laid such stress upon cost, we considered it our duty to make some further inquiries upon this subject; and we have received the most courteous replies from the engineers of whom we sought information.

In view of the letter from Mr. Jones, C.E., of Ealing, which also appeared in our issue of February 4th, our first desire was to compare the cost of the systems of destroying refuse and sludge mixed at Ealing and at Leyton.

Mr. Jones resented warmly the statement made in a non-technical contemporary, which has been repeated in many other journals, that the Leyton destructor was the first to deal successfully with sewage sludge, and we confess we sympathise with him. It is hard to hear such statements made after one has had a destructor doing that very thing for 15 years. Mr. Dawson, C.E., of Leyton, is kind enough to point out to us that his sludge is first pressed, whereas Mr. Jones's is unpressed.

We quite admit that pressing gives the stuff a soap-like consistency, and that it may be harder to burn pressed than unpressed; but, if so, why press it? We find that burning it unpressed is, from the point of view of cost, wholly in Mr. Jones's favour.

Mr. Dawson informs us that the cost of burning the refuse and sludge at Leyton works out to 1s. 7d. per ton for some months past, though taking only the last month it is 1s. 6½d.

To consider first the sludge alone.

We will assume that the cost of pressing is 6d. per ton of *wet sludge*. This we know to be a low estimate. The cost of burning is 1s. 6½d. per ton of *pressed* sludge. Assuming that one-third of the weight of wet sludge has been removed by pressing, this would amount to, say, 1s. per ton of *wet* sludge.

The total cost is, therefore, 1s. 6d. per ton of wet sludge for pressing and burning.

On the other hand, Mr. Jones states his cost at 1s. 1½d. per ton burned, exclusive of returns in the shape of sale of of clinker, &c.

Mr. Jones's 15 years' practice, therefore, appears to come out, as regards cost, superior to the "new departure" at Leyton. We make these remarks in the hope of eliciting further information in the comparison of the two systems.

At the same time, we do not profess to admire the low temperature system of destructors, and we believe that modern forced draught furnaces would, in Mr. Jones's hands, further secure his historical pre-eminence in sludge burning.

But if we are to pursue this question of sludge still further, what are we to say of Sir Douglas Galton's startling statement at Leyton in reference to the London sludge fleet?

We have now had an opportunity of studying his remarks at leisure in the *Leyton Express and Independent* of January 29th, which modestly refers to the destructor, in a leading article, as "*the pride of Leyton.*"

Sir Douglas Galton is reported to have said:—"In the metropolis a charge of above £100,000 a year is incurred to get rid of it [the sludge] by putting it into barges, from which it is dropped into the sea. That, I must confess, seems to me a wasteful process. . . . .

"Here, at Leyton, with the assistance of Messrs. Beaman and Deas, you have done much better than London now does. You have obtained a destructor which deals in a marvellous way with the refuse sludge. You avoid the cost of barging, for after removing it from your tanks, you have only to squeeze it thoroughly, and throw it into furnaces, and then the heat from its perfect combustion assists in working the necessary machinery."

Now we have seen that the cost of pressing and burning the sludge is about 1s. 6d. per ton of wet sludge at Leyton. We obtained from the London County Council the report of their able chief engineer, Sir Alexander Binnie, on the treatment of London sewage during 1896, this being the latest report for a complete year which was available to us.

We must say that Sir Alexander Binnie has no need of any champion to defend the system inaugurated by his distinguished predecessor, and improved by himself, for we have never read a more interesting, exact, comprehensive and satisfactory statement upon any branch of municipal business than this report.

We find from it that no less than 2,178,000 tons of sludge, containing 91·08 per cent. to 91·44 per cent. of moisture, were sent to sea in that year. The average cost of conveying this enormous mass of offensive matter 50 miles out was 3·4 pence per ton for working expenses, or 4·59 pence per ton inclusive of capital and all other charges. In view of these figures, does Sir Douglas Galton seriously advocate a substitution of the Leyton process for that now in operation at Barking and Crossness?

To put it at the lowest figure, we think London will object to paying an extra charge of 1s. 1d. per ton of sludge, or, in other words, £118,000 per annum, over and above the present cost, which is £41,654.

Allowances should be made for Sir Douglas Galton, as he was the "lion" of the occasion; and, presumably, his remarks were intended for a popular audience; but lions should be careful how they roar, particularly when they are well-known scientific authorities.

To return to the question of cost per ton burned for refuse in general, we have before us a report from which it appears that at the "Lero" destructor at Leicester, which is on the natural draught, low temperature system, under the management of the designer and patentee, Mr. Biddles, there were burned, in 1896, 12,956 tons of ashpit refuse; 373 tons of trade refuse; 147 tons of fish offal; and 267 mattresses. The total wages paid to firemen were £328.

We exclude the wages paid for repairs, mortar grinding, weighing in, and rat-catching, as we believe these items are not usually reckoned in the cost per ton burned.

The cost of labour per ton burned is, therefore, according to this statement kindly furnished to us by Mr. Biddles, under 6d. per ton.

From an interesting paper by Mr. George Darley, superintendent of the cleansing department at Leeds, published on January 29th last, in our esteemed contemporary, the *Public Health Engineer*, we learn that the cost of labour at the destructor at Meanwood, Leeds, is 7½d. per ton, while we are informed that at Bradford, Hammerton Street, it is 7d. per ton. The two last mentioned destructors are on the Horsfall system, and are worked at high temperatures under forced draught.

These figures show that the cost of labour at Leyton of 1s. 6½d. per ton burned is susceptible of very great improvement. It must not be forgotten that sludge is being burned at Leyton; but we think that the weighty nature of the sludge, and the fact that 60 per cent. of it is water, and requires only to be evaporated, more than compensates for its damping effect on the fires.

Moreover, other authorities have carried out tests at Leyton on refuse only, without sludge, and the costs published tend to confirm our opinion.

We look forward to the time when, at every important destructor, the costs will be kept and tabulated as carefully and completely as those relating to the disposal of the London sludge; or to name an example more familiar to our readers, the works' costs of practically every electricity station in the country.

ELECTRICAL NEWS FROM AUSTRALIA.

[FROM OUR SPECIAL CORRESPONDENT AT SYDNEY.]

AUSTRALIA has, unfortunately, recently added two more to the list of electrically caused deaths. On Sunday, September 11th, a lad named Richard Trusswell, aged 17 years, residing at Armadale, a suburb of Melbourne, challenged two companions to climb to the top of an electric light pole in Stanhope Street, Malvern, in less time than he could. The challenge being accepted, Trusswell quickly ascended the pole, and caught the wire with both hands, and almost immediately fell to the ground insensible. Medical aid was quickly summoned, but death had evidently been instantaneous. The lad's hands were terribly burnt, and one finger was burnt off at the joint. According to the evidence of his companions, sparks flew from his hands when he caught the wire, his legs came off the post, and after swaying a second or two he fell. He made no exclamation when he came in contact with the wire, but when, black in the face, he fell to the ground, he groaned once or twice, and then expired. The wire, which was insulated, was the property of the New Australian Electric Company.

The second instance occurred in Brisbane. On November 3rd, a man named Fox, foreman in charge of a gang doing repair work on the trolley line, received a shock and fell from the top of a waggon platform, and died within a few minutes, before medical aid could be summoned. The medical evidence showed that his skull was fractured, but it did not appear to be clear as to the exact cause of death: whether it was the shock, the fall, or both combined. There was no rail round the platform, and though rubber gloves appear to have been served out, they were not used. The men started work at 5.30, before current was turned on, and the accident happened immediately after 6.30, at which time current was turned on as usual for the first train to take up the regular running.

In connection with the various electric tram lines in Sydney, several contracts have been let, principally in connection with the George Street line. Tenders were called for the construction of permanent way and erection of poles in two sections, one going to J. McSweeney at £12,754, and the other to Wilmot & Morgan at £25,690, the highest tenders being respectively £18,118 and £31,820, 10 tenders being received for each; the contract for car house entrance going to H. W. Peabody for £1,200, as did also the construction of the crossing of the cable tram in King Street for £268. Messrs. G. & C. Hoskins are constructing the boilers locally, their accepted tender being for the sum of £4,718. The excavations for the power house at the back of Harris Street will cost £886, and is being carried out by C. McClure. Messrs. Noyes Bros., agents for Callender and Co., have secured the contract for the supply of feeder cables and junction boxes at schedule rates (about £7,540) for the George Street line, and also for the Rose Bay line at £459. The generators for the latter line are still lying outside the cable power house, but it is expected that they will be put in place before the end of the year, and the outside construction work will be commenced shortly. The estimated cost is £13,225. As before stated, Messrs. H. H. Kingsbury and Co., agents for the General Electric Company of U.S.A., are supplying generators for both lines.

The method adopted by the Goulburn (N.S.W.) Borough Council on entering into the question of electrically lighting the town has ended in a *fiasco*. As I mentioned in a former letter, the Council employed a consulting engineer, at an absurdly low fee, to draw up a "general specification," upon which tenders were called, with the result that so little being specified, a meeting of the electrical trades was held in Sydney to protest against the vagueness of the details supplied. First the consulting engineer was asked to give some more definite details of his requirements, and on his failing to accede, recourse was had to the Goulburn Council, who expressed themselves as highly indignant at being called upon to go to the expense of providing information, and one alderman, in defending the specification, said "the complaint came from a ring who desired the Council to expend money on information they should procure themselves." The majority of the aldermen defended the specification, "as the responsibility thrown on the tenders is a great saving to the Council." Out of the dozen or more firms who might have tendered, only two sent in.

The specification commences with a preamble to the following effect: "This specification is prepared with a view to enable electric light contractors to submit tenders to the Municipal Council of Goulburn, for the lighting of that city, on equal terms with one another, while leaving them entirely free to select those special classes of machinery and fittings which they represent or prefer. Contractors must understand that there is no intention of expressing any preference for particular types of boilers, engines, dynamos, conductors, or lamps, but they are to take the following particulars rather as statements of the conditions which they are to fulfil, and the basis on which rival tenders will be compared, &c." A map was provided, showing public lighting and the street frontages where provision is to be made for private lighting. A schedule of arc and incandescent lamps is then given, with the amount of watts required, the total being given as *66,000 watts*. Immediately below this comes the following delightfully ingenuous statement: "If the whole of the contract current of *80 kilowatts* is to be delivered from one dynamo, or if that portion of it required for the incandescent lights is to be supplied from one machine, and that for the arc lighting from another one of a different character; then there will require to be a complete duplication of the generating plant, altogether making the dynamos equal to a total of *160 kilowatts*; but should the contractor propose to supply both the arc and incandescent lights from two similar machines equal to 40,000 watts each, then a triplicate machine making a total possible output of 120 kilowatts will be sufficient as a reserve."

Not content with giving so many alternatives in the matter of generators, additional choice is given in the matter of sites, two being available at a considerable distance apart, and as one site is near the water works, with water handy for condensing purposes, the question of condensing or non-condensing engines is left for the poor unfortunate contractor to put in an alternative tender for. The power house is left entirely to the contractor's imagination and architectural ideas. In the matter of boilers the contractor is once again given a free hand. "Contractors will be at liberty to tender on either the 'internal fired,' 'water tube,' or 'multitubular' systems; and the matter of spare boiler power is arranged on the same plan as is adopted in the case of the dynamos, the contractors being permitted to put in two, three, or any other number they consider advisable;" the clause relating to boilers finishes as follows: "Although not here expressed in detail, it is to be understood that the most modern system of construction and highest class of workmanship is to be stipulated for by tenderers." In the clause relating to boiler-mountings, the following phrases occur: "The front fittings and doors are to be of handsome get up." . . . "One spare set of fire-bars *had better* be included, and two sets of fire tools." In referring

to steam pipes also the phrase occurs: "These pipes *had better* be of copper." The specification is also very open-minded on the subject of steam engines. "The engines are to be of compound type, either open or closed, and may be connected to the dynamo direct or by belts. Contractors who propose to drive smaller dynamos at a higher speed by belts must set against the saving in the cost of the dynamos the extra cost of the larger building required, &c." (What does this mean?) In dealing with the switchboard, superlative wisdom is shown in the remark that "The character of the switchboard will as greatly depend upon the nature of the scheme, that absolute requirements cannot be set forth." Why, certainly! Contractors are required to supply and fix all transformers, if any, that may be required; but apparently they are at liberty to state how many will be necessary, and the sizes of same. No mains are shown on plan, but they must be provided, and must have an insulation resistance of 600 megohms per mile "when coiled on the ground," and "the sections are to be so proportioned, that when carrying the full load, the fall of potential shall not be more than 2½ per cent. in either primary or secondary mains." (This latter information seems to show that the consulting engineer has a hitherto carefully concealed preference for alternating currents.) Coming to poles, the contractor is given another opportunity for diversion, by providing the option of galvanised tubular poles at the centres of street intersections, or iron brackets from the corners of buildings; and further, is permitted the choice of overhead or underground conductors, with the further advantage of a solid or draw-in system for the latter.

Towards the end a suggestion is airily thrown out that, after all, perhaps a continuous current transformer system might be preferred, and this is made further use of to perplex the already addled tender with its bearing on the use of open or closed arc lamps. At a low computation there would be no difficulty in sending in a hundred alternative tenders, all of which would comply with the specification. What a fortunate thing it is for the consulting engineer that only two firms have tendered, and that each have sent in only six alternative tenders for him to consider the merits of.

The Corporation of Port Adelaide (S.A.) have saved themselves all this bother by coming to terms with Mr. W. W. Crawfurd, agent for Messrs. Johnson & Phillips, who is undertaking the lighting of the town on the three-wire system with Johnson and Phillips' dynamos direct coupled to Belliss engines with a reserve of accumulators. It is understood that this work is being carried out by the same syndicate that is endeavouring to get a Bill through the South Australian Legislative Assembly with the object of lighting the City of Adelaide; the Bill is being strenuously opposed by the Adelaide Council in the belief, as they expressed it, "that the promoters were not a *bona fide* company anxious to carry out the electric work themselves, but rather a grasping syndicate wishful to secure electric rights for speculative purposes." The company, however, answered this by promptly offering to deposit £2,000 if the City Corporation would give them a contract for lighting Adelaide. In an examination in connection with this Bill the town clerk stated that the Corporation were paying between £4,600 and £4,700 per annum for 992 gas lamps. At Port Adelaide 130 gas lamps are being replaced by 24 arc lamps and 66 50-C.P. incandescents.

The question of private lighting was discussed at the meeting of the Melbourne City Council lately. A report was received from the Public Works Committee stating that Government sanction to the supply of light for public and private purposes by the Corporation had been secured, and recommending that advantage should be taken of the privilege. At charges of 5d. per unit for incandescent lamps, and £25 to £19 per annum each for arc lamps (according to the time they were kept alight) the present plant of the Council should give a revenue, when fully employed, of £5,295, besides supplying certain corporation buildings. Deducting the working expenses and other charges, this, the committee estimated, should leave a profit of £1,200. Many applications for the supply of electricity to private premises had been received, some of which were very urgent, and were being supplied. In the discussion which followed, several of the aldermen counselled delay, averring that unless the electric light improved considerably, it would be superseded by the Welsbach gas light. This idea was scouted by others, and ultimately the committee's report and suggestions were adopted.

Mr. Hesketh, the Queensland Government's electrical engineer, in reporting on the proposed electric lighting of Brisbane, states that he thinks electric lighting a proper and remunerative undertaking for the Corporation, and recommends that at first operations should be confined to the main streets of the city, using the direct-current system, with a three-wire distribution at 400 volts.

The first long distance telephone line in New South Wales, between Sydney and Newcastle, is almost completed. The connection is made by means of a cable passing through the telephone tunnel recently constructed in Pitt Street, thence into George Street North, joining the Harbour Cable at Dawes Point Battery to meet the overland line. The total length of line is close on 100 miles, and the tariff is to be 3s. for a three-minutes' conversation.

THE MEASUREMENT OF FAULT RESISTANCES WITH A VOLTMETER.

By STUART A. RUSSELL.

The first proposal to use a voltmeter for the measurement of the fault resistance of an electric circuit without interrupting the service dates back many years; but when it was first proposed, the conditions necessary to obtain a correct result were not properly understood, and even as late as 1889, it was stated in a paper read at the Institution of Electrical Engineers that if a voltmeter was connected from one conductor to earth, the total leakage current could be calculated by dividing the voltmeter reading in volts by the resistance of the instrument. In the discussion it was pointed out that such a method could not give correct results, but no description of the proper way of using the voltmeter was given by any of the speakers.

Although the correct method of measuring fault resistances with a voltmeter was published about this time, and must be well known to many readers of the Electrical Review, improper or incomplete methods are still frequently used, and the full amount of information that may be derived from a voltmeter test does not appear to be generally known. It is proposed, therefore, in this article to describe several applications of the use of the voltmeter and to draw attention to the results that may be obtained.

Two-wire Circuit.—In fig. 1 let A and B be the positive

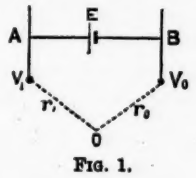


Fig. 1.

and negative conductors of a circuit having a difference of potential between them of E volts.

Let O be the earth taken at zero potential.

Let r_1 and r_0 be the fault resistances of A and B, and F be their combined resistance so that $\frac{1}{F} = \frac{1}{r_1} + \frac{1}{r_0}$.

Connect A to earth by a voltmeter of resistance G, and note the potential, V_1, of the conductor; then connect B to earth by the same voltmeter and note the potential, V_0, of B (which will be a negative quantity), and finally connect A and B and note the difference of potential, E.

Then $\frac{V_1}{r_1} + \frac{V_1}{G} + \frac{V_1 - E}{r_0} = 0$, or $V_1\left(\frac{1}{F} + \frac{1}{G}\right) = \frac{E}{r_0}$, (1)

and $\frac{V_0}{r_0} + \frac{V_0}{G} + \frac{V_0 + E}{r_1} = 0$, or $V_0\left(\frac{1}{F} + \frac{1}{G}\right) = -\frac{E}{r_1}$. (2)

By subtracting (2) from (1) we get $(V_1 - V_0)\left(\frac{1}{F} + \frac{1}{G}\right) = \frac{E}{F}$,

$$\text{whence } F = G\frac{E - (V_1 - V_0)}{V_1 - V_0}. \qquad (3)$$

From (1) and (2) we also see that $\frac{V_1}{r_1} = -\frac{V_0}{r_0}$ and by substituting this value of $\frac{V_1}{r_1}$ in (1) we get

$$-\frac{V_0}{r_0} + \frac{V_1}{G} + \frac{V_1 - E}{r_0} = 0, \text{ whence } r_0 = G\frac{E - (V_1 - V_0)}{V_1},$$

and in similar manner from (2) we get $r_1 = G\frac{E - (V_1 - V_0)}{-V_0}$.

It must be noted that if the voltmeter readings V_1 and V_0 are used without regard to the direction of the current through the instrument, the sign of V_0 must be changed in these equations as V_0 itself is a negative quantity; the equation for the combined resistance becoming

$$F = G\frac{E - (V_1 + V_0)}{V_1 + V_0},$$

whilst $r_0 = G\frac{E - (V_1 + V_0)}{V_1}$ and $r_1 = G\frac{E - (V_1 + V_0)}{V_0}$.

As the Board of Trade Regulations stipulate that the leakage current shall not be more than $\frac{1}{1000}$th of the maximum supply current, and as other regulations fix the maximum permissible ratio of leakage current to supply current, it is desirable that the value of the leakage current, c, should be known, and we see from the above equations that

$$c = \frac{E}{r_1 + r_0} = \frac{-E V_1 V_0}{G(V_1 - V_0)\{E - (V_1 - V_0)\}}.$$

When using a voltmeter in this manner the best results are obtained if its resistance is about equal to the combined fault resistance, that is when $V_1 - V_0 = \frac{E}{2}$. If the resistance of the voltmeter is much less than that of the fault, the readings are too low down on the scale where the calibration of most instruments is least accurate; whilst if the resistance of the voltmeter is very high compared with that of the fault, $V_1 - V_0$ is so nearly equal to E that a small percentage error in the values of E or of $V_1 - V_0$ causes a large percentage error in $E - (V_1 - V_0)$ which is the numerator in the equations. A convenient plan is to have the voltmeter fitted with one or two shunts which can be used as required to get suitable readings; the value of G used in the equations being, of course, the resistance of the shunted voltmeter.

If an electrostatic voltmeter, or one of very high resistance only is available, a resistance coil of known value, S, should be obtained and the test can then be made in the following manner: connect one conductor to earth by the voltmeter and note the reading, V, then shunt the voltmeter by the resistance, S, and note the reading V′. If the voltmeter is connected between A and earth (fig. 1), and we suppose the value of G so high that $\frac{1}{G}$ is negligible, we have

$$\frac{V}{r_1} + \frac{V - E}{r_0} = 0, \text{ or } \frac{V}{F} - \frac{E}{r_0} = 0, \qquad (4)$$

and when the shunt S is also connected between A and earth, we have

$$\frac{V'}{r_1} + \frac{V'}{S} + \frac{V' - E}{r_0} = 0, \text{ or } \frac{V'}{F} + \frac{V'}{S} - \frac{E}{r_0} = 0. \qquad (5)$$

From these two equations we get

$$\frac{V - V'}{F} - \frac{V'}{S} = 0, \text{ or } F = \frac{S(V - V')}{V'}. \qquad (6)$$

The values of r_0 and r_1 can be obtained separately by substituting in the equation $\frac{V}{F} - \frac{E}{r_0} = 0$, the value just obtained for F, which gives

$$r_0 = \frac{E S (V - V')}{V V'},$$

and since from equation (4) we know that

$$r_1 = r_0\frac{V}{E - V},$$

we get

$$r_1 = \frac{E S (V - V')}{V'(E - V)}.$$

The leakage current $c = \frac{E}{r_1 + r_0} = \frac{V V'(E - V)}{E S (V - V')}$.

Three-wire System.—Similar methods of determining the value of F may be used on a three-wire system, but under ordinary working conditions the separate values of the fault resistances of each conductor cannot be fixed. It is, however, possible to determine the minimum values that these fault resistances can have, and the maximum leakage current to earth that can exist under the conditions observed at the time of the test; and, further, by a modification of the conditions of testing, the actual values of the separate fault resistances can be determined.

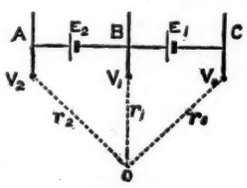


Fig. 2.

Let A, B, and C, be the three conductors, E_2 and E_1 the potential differences between A and B and between B and C, r_2, r_1, and r_0, the fault resistances of positive, neutral, and negative conductors, and F their combined resistance.

Connect A to earth by a voltmeter of resistance G and note the potential V_2 of the conductor, then connect C to earth by the same voltmeter, noting the potential V_0 of the conductor and finally measure E_2 and E_1.

Then $\frac{V_2}{r_2} + \frac{V_2}{G} + \frac{V_2 - E_2}{r_1} + \frac{V_2 - E_2 - E_1}{r_0} = 0,$

$$\text{or } V_2\left(\frac{1}{F} + \frac{1}{G}\right) - \frac{E_2}{r_1} - \frac{E_2 + E_1}{r_0} = 0. \qquad (7)$$

and $\frac{V_0}{r_0} + \frac{V_0}{G} + \frac{V_0 + E_1}{r_1} + \frac{V_0 + E_2 + E_1}{r_2} = 0,$

$$\text{or } V_0\left(\frac{1}{F} + \frac{1}{G}\right) + \frac{E_1}{r_1} + \frac{E_2 + E_1}{r_2} = 0. \qquad (8)$$

From these two equations we get

$$(V_2 - V_0)\left(\frac{1}{F} + \frac{1}{G}\right) - \frac{E_2 + E_1}{F} = 0,$$

$$\text{whence } F = G\frac{E_2 + E_1 - (V_2 - V_0)}{V_2 - V_0} = E, \text{ or if } E_2 = E_1 \qquad (9)$$

$$F = G\frac{2E - (V_2 - V_0)}{V_2 - V_0}.$$

It must again be noted that as the potential V_0 of C is negative, $V_2 - V_0$ is equal to the sum of the voltmeter readings, if these latter are used without regard to the direction of the current through the instrument.

From these equations it is not possible to determine the separate values of r_2, r_1 and r_0; but if the values of E_2 and E_1 can be varied, we can get two equations containing only two of the three unknown quantities. This method was first suggested to the author by Prof. Rousseau, of the Brussels University; the test being made at the time of minimum output by first making the ratio, $\frac{E_1}{E_2} = K$, as large as possible, and then repeating the measurements, after having changed the pressures so that $\frac{e_1}{e_2} = k$ is as small as possible. From the first set of measurements we can determine the value of F, as shown above, and we also get equation (7), which can be written

$$\frac{V_2}{E_2}\left(\frac{1}{F} + \frac{1}{G}\right) = \frac{1}{r_1} + \frac{1 + K}{r_0}. \qquad (10)$$

If now we change the pressures between the conductors and measure e_2, e_1 and v_2, we have

$$\frac{v_2}{e_2}\left(\frac{1}{F}+\frac{1}{G}\right)=\frac{1}{r_1}+\frac{1+k}{r_0}. \qquad (11)$$

Subtracting (11) from (10) we have

$$\left(\frac{V_2}{E_2}-\frac{v_2}{e_2}\right)\left(\frac{1}{F}+\frac{1}{G}\right)=\frac{K-k}{r_0}$$

or $r_0=\dfrac{E_2\,e_2\,(K-k)}{(e_2\,V_2-E_2\,v_2)\left(\frac{1}{F}+\frac{1}{G}\right)}$. By substituting this value of r_0 in equation (10) we can get the value of r_1; and r_2 can then be calculated from $\dfrac{1}{r_2}=\dfrac{1}{F}-\dfrac{1}{r_1}-\dfrac{1}{r_0}$.

If it is not convenient to vary the values of E_2 and E_1, it is still possible to determine the minimum values which any of the three resistances can have, and also the maximum leakage current to earth.

We know from (7) and (8) that

$$V_2\left(\frac{1}{F}+\frac{1}{G}\right)=\frac{E_2}{r_1}+\frac{E_2+E_1}{r_0}$$

and

$$-V_0\left(\frac{1}{F}+\frac{1}{G}\right)=\frac{E_1}{r_1}+\frac{E_2+E_1}{r_2}$$

From these equations we see that r_2 and r_0 will have their minimum values when $\frac{E_1}{r_1}$ and $\frac{E_2}{r_1}=0$, *i.e.*, when $r_1=\infty$; and, similarly, r_1 will be a minimum when either r_0 or r_2 is infinite. We, therefore, get the following values:—

$$r_2\text{ min.}=\frac{E_2+E_1}{-V_0\left(\frac{1}{F}+\frac{1}{G}\right)}=\frac{F\,(V_2-V_0)}{-V_0}=\frac{G\left\{E_2+E_1-(V_2-V_0)\right\}}{-V_0}$$

$$r_1\text{ min.}=\frac{E_2}{V_2\left(\frac{1}{F}+\frac{1}{G}\right)}=\frac{E_2F(V_2-V_0)}{V_2(E_2+E_1)}=\frac{GE_2\left\{E_2+E_1-(V_2-V_0)\right\}}{V_2(E_2+E_1)}$$

$$\text{or}\quad=\frac{E_1}{-V_0\left(\frac{1}{F}+\frac{1}{G}\right)}=\frac{E_1F(V_2-V_0)}{-V_0(E_2+E_1)}=\frac{GE_1\left\{E_2+E_1-(V_2-V_0)\right\}}{-V_0(E_2+E_1)}$$

according to whether V_2 is numerically smaller or greater than V_0,

$$r_0\text{ min.}=\frac{E_2+E_1}{V_2\left(\frac{1}{F}+\frac{1}{G}\right)}=\frac{F\,(V_2-V_0)}{V_2}=\frac{G\left\{E_2+E_1-(V_2-V_0)\right\}}{V_2}$$

The maximum leakage current to earth will occur when r_2 or r_0 is a minimum, that is, when $r_1=\infty$ and is equal to

$$\frac{E_2+E_1}{r_2+r_0}=\frac{E_2+E_1}{F\,(V_2-V_0)\left(\frac{1}{V_2}-\frac{1}{V_0}\right)}=\frac{-V_2V_0\,(E_2+E_1)}{F\,(V_2-V_0)^2}$$

If an electrostatic or high resistance voltmeter is employed to make the test, one conductor, say A, is first connected to earth through the voltmeter, and the reading, V, is noted; and then the shunt, S, is also connected between A and the earth, and the reading, V′ is noted. We then have

$$\frac{V}{r_2}+\frac{V-E_2}{r_1}+\frac{V-(E_2+E_1)}{r_0}=0,\text{ or }\frac{V}{F}-\frac{E_2}{r_1}-\frac{E_2+E_1}{r_0}=0 \qquad (12)$$

and

$$\frac{V'}{S}+\frac{V'}{r_2}+\frac{V'-E_2}{r_1}+\frac{V'-(E_2+E_1)}{r_0}=0,$$

or

$$\frac{V'}{F}+\frac{V'}{S}-\frac{E_2}{r_1}-\frac{E_2+E_1}{r_0}=0; \qquad (13)$$

whence

$$\frac{V-V'}{F}-\frac{V'}{S}=0,\text{ or }F=\frac{S\,(V-V')}{V'}. \qquad (14)$$

By assigning, as before, different values to the ratio $\frac{E_1}{E_2}$, the values of r_2, r_1, and r_0 can be calculated, since we get

$$\frac{V}{F\,E_2}=\frac{1}{r_1}+\frac{1+K}{r_0}\text{ and }\frac{v}{F\,e_2}=\frac{1}{r_1}+\frac{1+k}{r_0},$$

whence

$$\frac{1}{F}\left(\frac{V}{E_2}-\frac{v}{e_2}\right)=\frac{K-k}{r_0}\text{ or }r_0=\frac{F\,E_2\,e_2\,(K-k)}{e_2\,V-E_2\,v}.$$

When the values of E_2 and E_1 cannot be varied the minimum values of r_2, r_1, and r_0, and the maximum leakage current can be calculated as follows:—We have from (12) and (14)

$$\frac{E_2}{r_1}+\frac{E_2+E_1}{r_0}=\frac{V}{F}=\frac{V\,V'}{S\,(V-V')},$$

from which we see that

$$r_0\text{ min.}=\frac{(E_2+E_1)\,(V-V')\,S}{V\,V'}\text{ when }r_1=\infty,$$

and

$$r_1\text{ min.}=\frac{E_2\,(V-V')\,S}{V\,V'}\text{ when }r_0=\infty.$$

The equation (12) may also be written

$$\frac{E_1}{r_1}+\frac{E_2+E_1}{r_2}=\frac{E_2+E_1-V}{F}=\frac{V'\,(E_2+E_1-V)}{S\,(V-V')}$$

from which we see that

$$r_2\text{ min.}=\frac{(E_2+E_1)\,(V-V')\,S}{V'\,(E_2+E_1-V)}\text{ when }r_1=\infty,$$

and

$$r_1\text{ min.}=\frac{E_1\,(V-V')\,S}{V'\,(E_2+E_1-V)}\text{ when }r_2=\infty.$$

The maximum leakage current to earth will occur when r_2 and r_0 have their minimum values and $r_1=\infty$, so that

$$e=\frac{E_2+E_1}{r_2+r_0}=\frac{V\,V'\,(E_2+E_1-V)}{(E_2+E_1)\,(V-V')\,S}.$$

Either of the voltmeter methods described above can, as we have indicated, be made to give very valuable information concerning the condition of the mains; and as the tests require very little apparatus and are easily and rapidly made, it is somewhat surprising that so few central stations should be provided with fault measuring instruments as part of the ordinary switchboard equipment. The author has found the high resistance voltmeter method the more convenient in practice, and has used it in conjunction with a high resistance registering voltmeter permanently connected between one main and earth: the continuous record of the variations of earth potential coupled with the results of periodic measurements of V and V′, forming a fairly complete record of the condition of the mains.

The fault resistances measured by the above methods are those of the complete circuit, including dynamos, batteries, mains, and house circuits; and if it is desired to measure the resistance of a part of the circuit, it is necessary to isolate that part from the remainder and measure its fault resistance in some other way. This may be done with a portable testing set and battery or magneto, but by a slight modification of method, the fault resistance of a house circuit, or of any section of the circuit that can be isolated for a minute or two from the remainder, can be measured by the voltmeter using the street mains to supply the testing pressure, and thus doing away with the necessity for a special testing set and battery or magneto.

In fig. 3 let A and B be the conductors of a two-wire main, having a difference of potential, E, between them; and

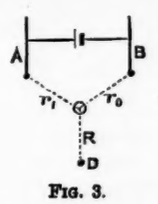


Fig. 3.

let D be a terminal, to which are connected the conductors of the house circuit or other section of the mains whose fault resistance R is to be measured, it being understood that the section under test is disconnected entirely from the live mains. Using the same notation as before, we have, when the voltmeter is connected between A and O, from equation (1)

$$\frac{E}{r_0}=\frac{V_1\,(F+G)}{F\,G},$$

and when connected between A and D,

$$\frac{E}{r_0}=v_1\left(\frac{1}{F}+\frac{1}{G+R}\right)=v_1\left\{\frac{F+G+R}{F\,(G+R)}\right\}=v\left(\frac{F+G+R}{F\,G}\right)$$

if v is the voltmeter reading and v_1 the potential of A under these last conditions. From these equations we get

$$V_1 (F+G) = v (F+G+R) \text{ or } R = \frac{(V_1 - v)(F+G)}{v} = \frac{(V_1 - v) G E}{v (V_1 - V_0)}$$

If an electrostatic or high resistance voltmeter is employed, A and D are connected by a resistance S, and the potential differences V between A and O, and V′ between A and D, are measured, then

$$\frac{V}{S+R} = \frac{V'}{S} \text{ or } R = \frac{S (V - V')}{V'}.$$

In this latter case the same result is obtained if the mains are on the three-wire system, and in the former case we have from (7)

$$\frac{E_2}{r_1} + \frac{E_2 + E_1}{r_0} = \frac{V_2 (F + G)}{F G},$$

and

$$\frac{E_2}{r_1} + \frac{E_2 + E_1}{r_0} = v_2 \left\{ \frac{F + G + R}{F (G + R)} \right\} = v \left(\frac{F + G + R}{F G} \right)$$

from which we get

$$R = \frac{(V_2 - v)(F + G)}{v} = \frac{G (F_2 + F_1)(V_2 - v)}{v (V_2 - V_0)}.$$

For this test also the high resistance voltmeter will generally be found more convenient, especially if fitted with two or three shunts, so that the value of S may be varied so as to get convenient readings. As any circuit or section of a circuit can be tested by disconnecting it for a few minutes from the live mains, this test can be employed to localise a fault, the existence of which has been indicated by the test of the complete circuit. For instance, in the case of a house circuit, each circuit leaving the distribution board can be disconnected and tested in turn, and the faulty circuit so found may be further divided up by removing the branch fuses. In a similar manner sections of a network of underground mains can be tested with very little inconvenience to customers, as each section is only disconnected for long enough to take two readings of the voltmeter.

PRESENTATION TO MR. F. H. WEBB.

It is not often that one is called upon to attend so pleasant a function as that which took place at the Whitehall Rooms on Monday evening. Still rarer is it to find an electrical gathering imbued with so marked an unanimity and with so conspicuous a desire to do distinguished honour to one associated with electrical engineering. The occasion was the presentation to Mr. F. H. Webb, the retiring secretary of the Institution of Electrical Engineers.

There was a geniality suffused over the whole proceedings, which may have been partly due to the event and partly to the presence of many fair women. There were many distinguished members of the Institution present, among them Sir Henry Mance, Mr. J. W. Swan, Sir William Crookes, Prof. Hughes, Major-General Webber, Mr. H. Edmunds, and Mr. E. Manville.

The proceedings were commenced by many of the subscribers dining together, with Mr. and Mrs. Webb as guests. Subsequently a reception was held, and shortly after 10 o'clock we proceeded to the real business of the evening.

Sir Henry Mance, as chairman of the Executive Committee of the Testimonial Fund, called upon the honorary secretary of the fund, Mr. H. Edmunds, to give a short account of the initiation of the testimonial. In setting forth the details of the scheme to present a testimonial to Mr. Webb, in recognition of his long and successful service in the interests of the Institution of Electrical Engineers, Mr. Edmunds pointed out the wide interest that had been taken in the proposal, and that it had received the support of members of the Institution in all parts of the world. They had practically received £750 as subscriptions, and in accordance with the wishes of Mr. Webb, it was proposed to invest this sum in the names of two trustees, Mr. Manville and himself. An illuminated address, having the signatures of the 1,000 contributors, was then referred to by Mr. Edmunds, the text of which is as follows:—

Address to Mr. Francis Hughes Webb,
Secretary Institution of Electrical Engineers, 1878—1898.

February, 1898.

Dear Mr. Webb,—Upon the occasion of your retirement from the secretaryship of the Institution of Electrical Engineers, we, the undersigned members, foreign members, associates, and students of the Institution, desire to give expression to the deep sense that we entertain of personal and corporate indebtedness to you.

For 20 years you have devoted the whole of your untiring energy to that office with a single mind to the interests of the Institution; and the increase in the number of members during these years, from 800 to nearly 3,000, coupled with the soundness of the financial position to which the Institution has attained in the same period, sufficiently attest the value and the success of your labours.

In conducting the work of the office, your uniform and unfailing courtesy, tact, sympathy and kindliness, have endeared you to all with whom you have been brought in contact. And now, in presenting you with this address, together with a sum of money amounting to upwards of £600, and a diamond brooch, which we beg Mrs. Webb to accept as a token of our esteem, we earnestly hope that for many years you may be spared with her to enjoy the rest that you have earned so well, and we trust that the Institution may long be permitted to have the benefit of your experience, which has proved so valuable to it in the past.

We beg also that you will regard the autograph signatures in this album as those of true and sincere friends.

We are, dear Mr. Webb,

On behalf of the subscribers,

Signed by the Members of the Executive Committee.

Major-General Webber, as one of the founders of the Institution, then spoke in eulogistic terms of the long services rendered by Mr. Webb. He had joined the Institution at a time when, as the Telegraph Society of Engineers, the number of members did not exceed 200 or 300, and when the society had not been commercially successful. The speaker briefly referred to the fact that Mr. Webb, even before he joined the Institution, had been connected with several branches of engineering. He concluded by making an eloquent tribute to the manner in which Mr. Webb had conducted the affairs of the Institution.

Then Sir Henry rose to make the presentation, and in doing so, referred to the fact that Mr. Webb had served under 19 different presidents. On all occasions he had been ever ready to listen to suggestions, whether from the council, from members, associates, or students. The chairman then handed to Mr. Webb a silver box containing a cheque, and the album containing the illuminated address and the signatures of the subscribers. In doing so, he wished the recipient many years of life to enjoy the rest he had so richly deserved.

The chairman then presented a handsome diamond brooch to Mrs. Webb.

Mr. Webb, who, upon rising to respond, was received with loud applause, referred to the difficulties of his position. He had been overwhelmed with kindness, and it was impossible for him to properly express his feelings. Speaking of his long connection with the Institution, Mr. Webb said when he accepted the secretaryship he did so with the knowledge that he was really going among friends, for many of the members of the Institution were known to him previously. He thanked the members of the committee and the members of the Institution generally for what they had done. He appreciated the honour more than he could say, and his sons abroad—and he had one in India, one in America, and one in Australia—would be proud to know of the honour done to him.

The proceedings were terminated by a vote of thanks to the executive committee.

At the conclusion of the ceremony, there was a wish expressed that arrangements might be made for the collection of a second volume of autograph signatures of members, associates, and students of the Institution, as it was felt that there must be, among the 2,000 members whose autographs were not included, many who would regret that they had lost the opportunity of expressing their sympathy with the movement. We understand that Mr. Edmunds, as honorary secretary to the Testimonial Fund, will be most happy to receive any further signatures and subscriptions that may be sent hereafter to his office, 39, Victoria Street, S.W. Both autographs and subscriptions will be handed to Mr. Webb, and the total amount received will, from time to time, be announced in the Technical Press.

CORRESPONDENCE.

Shoreditch Dust Destructors.

In view of the very kind reception accorded to me on two occasions at the Shoreditch works by Mr. H. E. Kershaw, the chairman of the Electric Lighting Committee, and by Mr. C. Newton Russell, the chief electrical engineer, I greatly regret that I should have felt compelled to offer any adverse criticism to the plan of combining dust destruction with electricity works as exemplified there.

That I am impressed with the advantages arising from the conversion into electrical energy of the heat generated in dust cremation is sufficiently evidenced by the fact that I am at present designing three such schemes.

When, however, under cross-examination on the subject by the members of the Gloucester Town Council, I felt bound to place among the *contras* the inconvenience arising from the entry of dust into the electricity works.

Hot bearings and scored commutators are very unpleasant incidents, and the visits to the Shoreditch works confirmed my opinion that in order to avoid them in combined works, extra vigilance, and, possibly, extra expenditure on cleaners, would be necessary.

Your condensed report of my hour's interview with the Gloucester Town Council is, in the main, most accurate, but one or two remarks are without their context, and I venture to supply in italics below the omitted and qualifying words.

"Personally he would rather not have the dust destructor next door to his electricity works, for the one reason that the dirt and dust made it more difficult to carry the electricity works on with a dust destructor in the immediate vicinity. Besides, they could not keep the machinery and building so smart and tidy as they could if the dust destructor was half-a-mile away. . . . . At Shoreditch the dust considerably interfered with the machinery. The works there were ill-designed *for keeping out the dust*, and if he were asked to draw up a scheme of combination he should take care that the dust destructor portion was entirely closed up from the electricity works, instead of being connected by windows and doors as at Shoreditch. . . . . he would rather not run the risk of having his smart machinery interfered with, but still he believed those difficulties might be got over, and the saving undoubtedly would be what had been stated. Mr. C. G. Clark asked if there was any possibility of the dust interfering or damaging the machinery providing the works were properly constructed . . . . the nearest approach to the works not being interfered with was at Cheltenham. There the destructor was separated from the electricity works by a promenade. They had plenty of room there, more than they wanted to take in Gloucester. He knew of no place where a certain amount of dust did not come in. When he recommended the combination he had, of course, considered the pros and cons, and if they had it they must put up with the disadvantage of some amount of dust, and that would require greater care in cleaning the machinery, because there was nothing so dangerous to electric plant as dust. At Shoreditch, *on the occasion of his two visits*, some of the machinery was disabled from that cause, but as to whether he could keep it out he would be able to tell them better when he had erected the Gloucester works."

I now learn from the two gentlemen best qualified to judge that I was mistaken in supposing that the motors driving the fans to which I referred had been disabled through the dust, and I must express my regret that I made a false inference; but when I noticed that first one and then another was dismantled, I could attribute the cause to none other than "dust," of the presence of which in the electricity works there was other evidence, rather than suppose that the plant had failed from any but extraneous causes within a few months of completion.

Robert Hammond.

The Yarrow Home.

You were kind enough in your issue of May 15th, 1896, to publish a description of the Yarrow Home for Convalescent Children at Broadstairs.

I have the pleasure to report that since the opening of this institution a little over 2 years ago, no less a number than 1,299 children have been benefitted by a stay there. It will be remembered that the Home is fully endowed and no subscriptions are required, also that it is not intended for the very poor, but for children who have been well brought up and whose parents cannot afford to send them to the seaside entirely at their own expense.

During the summer months the applications for admission are far in excess of the capabilities of the Home, but in the winter it is only partly filled, and the trustees are most anxious to maintain its utility equally throughout the year. There is little doubt that the falling off in applications during the winter may arise from the fact that the Home is thought not to be a very desirable resort during the inclement part of the year, but such is not the case. The building is thoroughly warmed and ventilated, a healthy temperature being maintained throughout; and there are play corridors within and playgrounds without.

The grounds are planted and well sheltered, and there are but very few days in the year when children cannot enjoy the fresh air even when the weather debars them from going to the sea front.

T. Fredk. Myers,
Secretary of the Yarrow Home.

73A, Queen Victoria Street, E.C.

A Protest.

I notice in your issue of February 18th, an advertisement for a shift engineer, at the princely salary of £50 a year. It certainly appears to me that the unfortunate shift engineer of the future will not only be held responsible for the working of £10,000 worth of machinery for eight hours every day, but will also be expected to "tip the chief engineer" for being allowed to do it. No doubt Mr. Boot is very proud of that passage in his report which runs: "Tunbridge Wells is the only station working on the high tension system which has not made a call upon the ratepayers in the first completed year's working." It seems probable to me that the staff were called upon instead of the ratepayers. Possibly the air of Tunbridge Wells is so invigorating that shift engineers require no dinner; or, perhaps, as it is near springtime, the happy successful candidate will lightly turn his thoughts to love—and live on that. Is it not time that, in these days of successful stations, junior electrical engineers should receive a fair day's pay for a fair day's work? Mr. Boot is evidently more successful in drawing up high-sounding reports than in learning what constitutes a "living wage." My hearty sympathies are with the successful candidate.

Disgusted.

I note in your issue of the 18th that a *shift engineer* is required at Tunbridge Wells at the enormous *salary of £50 per year*, but the applicants must have had experience of high tension working.

It is, I think, an enormity that the managers of an undertaking such as Tunbridge Wells should make such an offer. The results of last year's working show a net surplus of £887, and yet this Corporation thinks that £50 a year is sufficient salary for an experienced man in such an expensive place as Tunbridge Wells. There is no excuse of poverty or a station on which losses are being made, and I think that a stand should be made against such barefaced offers. The pity of the whole business is that they will get a man (?) at the price, and I can only hope that he will give them no more than value for their money.

Some months ago I answered a private notice at the Technical College, Finsbury, for an engineer experienced in high tension work to take charge of the running, and be responsible to the chief engineer for the satisfactory working of the plant at this station. Everything went on very well until the question of salary was reached. I ventured to hint that say 35s. a week, with a good prospect of a rise would meet the case, and received in reply a *post card* from the chief engineer, if you please, stating that they could not think of paying as much as that. I afterwards heard that they had two assistants fresh from a technical college, whom they were paying *nothing*. No wonder that the station

shows such good results. I believe I could make a high tension station pay if I received labour and material gratis. But, seriously, is £50 per annum sufficient for an experienced man who has to work through the night, and has such heavy responsibility on his shoulders?

I would venture to suggest that you should refuse all such advertisements in future, and by so doing you will help to break this ring of low prices, which are less than a road-scraper can obtain from the parish.

W. Fennell.

8, Ferndale Road, Leytonstone.

NOTES.

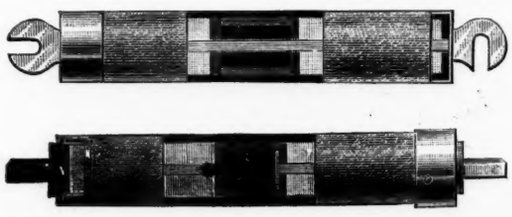
Improvements in Storage Batteries.—By means of certain improvements in battery plates, a new cell has been completed by Mr. Rankin Kennedy, which gives, we are informed, a very much greater output per pound weight than is usual. This cell has been under experiment for two years, and the object of the improvements have been to do away with the heavy grid used in battery plates, so as to render the whole of the active materials useful. Recent tests by Dr. William Peddie, D.Sc., F.R.S.E., Physical Laboratory, Edinburgh (whose figures, by the way, we should like to see for ourselves), result in the conclusion that the capacity of the new cell is 13 watt hours per pound of battery, and 32·8 watt hours per pound of positives at normal rates of discharge. The active material is not in the form of plugs, which are always liable to fall out or loosen; it is held securely in contact with conductors ramified throughout the mass. Careful tests have been made up to discharge rates equal to five amperes per pound of positives, without the least signs of buckling. The new cell will be shortly put in the market in two types, one for traction purposes, and the other for stationary wants. We hope Mr. Kennedy's battery will turn out as well commercially as it looks on paper, and if the long years of experience and knowledge of what to avoid go for anything, we anticipate that a real advance in accumulators has been made.

Advice to Boiler Attendants.—We are in receipt of a new issue of advice to boiler attendants, issued by the Manchester Steam Users' Association, over the signature of their new chief engineer, Mr. Chas. E. Stromeyer. In the sheets at one time issued, it was stated that the best advice the Association could give in regard to the occurrence of low water was "not to let it occur," which reminds one of *Punch's* advice to those about to marry; but there was always some, if an unconscious humour, about the Manchester Steam Users' Association, and the strain remains to-day. After a few remarks on what to do with collapsed furnaces and bare crowns, it is naively stated that, in face of these dangers, the boiler attendant may prefer to retire. Among the warnings is one to ease the safety valve before opening the manhole cover, so as to be quite sure there is no steam in the boiler. This advice is dangerous, being insufficient. Easing a safety valve is understood to imply lifting, and, perhaps, propping the lever, but the valve itself ought to be lifted; it is often heavy enough to confine steam in a hot boiler quite sufficient to lift the unbolted manhole cover and rush out in a scalding torrent. We have seen it happen.

High Speed Sentinel Steam Engines.—Messrs. Alley and Maclellan, of Glasgow, have forwarded us a copy of their new steam engine catalogue. In it are particulars of the firm's make of Westinghouse type, simple and compound engines. There are now 6,000 simple engines at work—an encouragement to the firm to build compound engines on similar lines up to 250 H.P. They have now some 12,000 H.P. of compound engines at work. The catalogue is well arranged, and the engines it describes are all shown diagrammatically, with all leading dimensions tabulated. Copies of indicator diagrams are given; these show good adjustment. All engines are made strictly to gauge and interchangeable throughout.

Dublin Cables.—In connection with the "scare" in rubber cables to which we referred in our last issue, it will be interesting to review the reported facts in connection with the underground mains in Dublin. After a number of years working without trouble, the arc light mains broke down in several places, this cable, we are informed, being small and unsuitable, apparently, for the mechanical strains it was called upon to bear from time to time. Extensions were contemplated, and the two matters were dealt with together, the Board of Trade being asked to hold an inquiry on a loan for "renewals of cable," the superintendent reporting that a complete renewal was absolutely necessary, and Prof. Kennedy, F.R.S., whose advice was sought, acting on the report of the superintendent, and, no doubt, on his appreciation of other reports on similar cables, agreeing that a complete renewal was a matter of necessity. When the Board of Trade inquiry was held it was ascertained that the money was not required for renewals of cable, but for extensions. The title of the demand was no doubt based on the theory that it would have been easier to get the loan for renewals as being pressing than for extensions, and, during the course of the inquiry, the superintendent is reported to have said that, although the cables had failed here and there, the real loss on the old cables would only be £1,300 out of the £20,000 applied for, as they wished to take out some of the old cables to enable them to change the "system." On being pressed, he admitted that an expenditure of £500 would restore the faulty cable, and they could be used again. It is difficult from the reports to reconcile these different statements, and Mr. Thompson, T.C., apparently could not, as in his examination he stated that the whole cables had been condemned by the Council, and there was never a word said about mere repair. Surely some more light should be thrown on this matter, since it would appear from the facts before us that the report of the superintendent on which Prof. Kennedy, in part, at least, would naturally rely, was not made at all in accordance with the evidence he finally gave when the question of renewals became for other reasons, no doubt, subordinated to that of extensions. The only explanation we can suggest at present is, that it was the "system," and not the type of cable, that was condemned. Still, as reported in the electrical press, the cables were stated to be in fault, possibly because the engineers who make technical reports select the system, whereas it is only the contractor who makes the cables.

Air-tight Fuses.—In the Cartwright enclosed air-tight fuses, the fuse is so constructed that the wire melts within the central chamber of the tube and the heated air and gases formed thereby force themselves to the end sections, thus blowing out the arc. This fuse, says the *Electrical World*, can be used on any pressure less than 2,200 volts. It is stated that it will not maintain an arc between its terminals when short-circuited on the mains of a 2,200-volt composite alternating dynamo. The cut-out consists of two parts, namely, the base and tube. The base is made of the best quality of Monson slate, and the tube is made of black or grey



fibre. Owing to the peculiar construction of this device, the fuse in a 3-inch tube will, it is stated, open the circuit, where other cut-outs require twice that length of fuse to operate under the same condition. This fuse has a definite length, cannot come in contact with any foreign substances, and will open the circuit in a pre-determined time on a given current. After a fuse has blown it is replaced by a new tube. Each fuse is marked with the maximum number of amperes it will carry indefinitely. These fuses are manufactured by the Shawmut Fuse Wire Company, of Boston, Mass., under license from the Goodhart Electric Company.

The Electric Migration of Colloids.—A little time ago some researches were initiated by Cöhn with a view to throwing some light upon the subject of electric migration, especially of colloids. In the first stage of the research the conclusion was arrived at that coloured ions exist, because coloured fluid follows the direction of the current during electrolysis. Nernst has also studied this subject, and our readers are familiar with most of his work. They may remember an experiment which he described in which, during the electrolysis of permanganate of potash, the MnO_4 ions moved towards the anode, and it is generally recognised now that a substance which is free to move will move in or against the direction of the current if it be electrically charged. Fine suspended solid particles, suspended in water or in turpentine, will, by reason of the static charges which they bear, move towards the oppositely charged electrode, whilst the liquid particles move towards the other electrode. More recently Cöhn, working in conjunction with Euler, found that such substances as caramel, starch and tannin, which are colloidal in character, and non-electrolytes, behave in a manner exactly similar to the behaviour of the solid particles suspended in water or turpentine; they actually move in the water towards the anode. Of course this fact has already been noticed in the case of tannin, and is the foundation of the process of electric tannin. Cöhn has also investigated the behaviour of colloids in which electrolytic dissociation might possibly take place, for example, in dialysed ferric hydroxide. The hydroxide was first purified by means of electrolysis with a silver anode, and was then submitted to a current between two layers of water. It was then observed that a dark layer moved towards the anode, whilst a lighter coloured layer moved towards the cathode. Now the layer would not pass through a parchment membrane, and hence could not contain iron ions. These observations are exceedingly interesting, inasmuch as they throw light upon a subject which is very obscure, and concerning which information is really demanded. We are glad to hear that the subject is being more fully investigated, and shall look forward to further results. The present research is described in the *Zeitschrift für Elektrochemie*, No. 4, pages 63—66.

Manufacturing Aluminium and its Sulphides.—An interesting application of electrolysis to the manufacture of aluminium, sulphide of aluminium, &c., has recently been successfully carried out by D. A. Peniakoff at Huy, in Belgium. The essential features of the process are as follows:—A single or double anhydrous aluminium salt, such as a fluoride or chloride, fused with the sulphide of an alkali or alkaline earth, together with a chloride or fluoride as a flux, yields a mixture containing aluminium sulphide, from which, in the same crucible, aluminium may be reduced, either by the action of an electric current, or by means of reducing gases (such as hyrocarbons, for example). The following formulæ present examples of the preparation of aluminium sulphide:—

(1) $Al_2 F_6 + 3 Na_2 S = Al_2 S_3 + 6 Na F.$

(2) $Al_2 F_6, 6 Na F + 3 Na_2 S = Al_2 S_3 + 12 Na F.$

(3) $Al_2 Cl_6, 6 Na Cl + 3 Na_2 S = Al_2 S_3 + 12 Na Cl.$

When the bath is constituted according to the reactions (1) or (2), if aluminium be reduced from the fused mass, the supply of aluminium sulphide is kept up by additions of aluminium sulphate and carbon; aluminium fluoride and sodium sulphate are first formed, according to the equation $Al_2 3 SO_4 + 6 Na F = Al_2 F_6 + 3 Na_2 SO_4$, and the sodium sulphate is reduced to sulphide by the carbon, with subsequent production of aluminium sulphide, according to equations (1) and (2). It is stated that even where the sulphide of aluminium produced in the bath is subjected to electrolysis, the sulphide alone may undergo the electrolytic action, and not the fluoride, as the latter requires for its electrolytic decomposition a far greater electromotive force than that which suffices to bring about the decomposition of the sulphide of aluminium. Besides, where electrolysis is resorted to, the sulphur separated from the aluminium serves, for the most part, to reduce the alkaline sulphate to the condition of alkaline sulphide, thus adding its effect to the action of the carbon.

(*Continued on page* 263.)

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Feb. 22nd, 1897.	£	s.
Alexandria	122	0
Amsterdam	45	0
Antwerp. Teleg. mat...	30	0
Auckland	80	0
Bangkok. Teleg. mat...	90	0
Bilbao	170	0
Bombay	139	0
Brisbane	72	0
Buenos Ayres. Teleg. mat.	76	0
Calcutta	300	0
Cape Town	484	0
Copenhagen. Teleg. wire	10	0
Durban. Teleg. mat. ...	151	0
East London	493	0
Gibraltar. Teleg. mat...	650	0
Gothenburg	26	0
Hamburg. Teleg. mat.	290	0
Hong Kong	247	0
Madras	71	0
Madeira	97	0
Malta	101	0
Passages	831	0
Port Elizabeth	109	0
Rangoon. Teleg. mat ..	20	0
Rosario	50	0
Rio Janeiro. Teleg. mat.	350	0
Singapore	37	0
,, Teleg. mat. ..	15	0
Sydney	1,246	0
Vera Cruz	60	0
Yokohama	361	0
Total	£6,863	0

Week Ending Feb. 22nd, 1898.	£	s.
Albany	42	0
Amsterdam	84	0
Barcelona	10	0
Bombay	70	0
Buenos Ayres	130	0
Calcutta	74	0
Cape Town	183	0
Durban	126	0
East London	81	0
,, Teleg. mat.	2,747	0
Flushing	227	0
Fremantle	1,325	0
Gothenburg. Teleg. mat.	216	0
,, Teleph. mat.	875	0
Malaga	158	0
Monte Video	30	0
North Sea	5,843	0
Perth	320	0
Port Elizabeth	764	0
,, ,, Teleg. mat.	421	0
Rangoon	1,575	0
Rosario	55	0
,, Teleg. mat. ...	61	0
Rotterdam	240	0
Singapore	45	0
Sydney	99	0
Trieste. Teleg. cable ...	2,050	0
Tahiti	6,000	0
Yokohama	10	0
Zanzibar. Teleg. cable	24,480	0
Total	£48,341	0

Bankruptcy Proceedings.—The first meeting was held last week at the London Bankruptcy Court of the creditors of John Dewhurst, electrician and sanitary engineer, 52, North End Road, S.W. The debtor, who presented his own petition, commenced business nine years ago at North Kensington, and removed about 1893 to his present premises. He attributes his insolvency to a loss of £250 sustained through the defalcations and misconduct of a former traveller. The accounts show unsecured debts £315 9s 10d, and assets £121 5s. 8d. An offer of 6s. 8d. in the £ was made to the creditors recently, but it was not unanimously accepted, and the debtor subsequently petitioned the Bankruptcy Court. No offer was now submitted, and the creditors left the estate in the hands of the official receiver to be wound up in the usual manner.

Dissolutions of Partnerships.—Messrs. F. Woolnough and H. A. Procter (Woolnough & Procter, electrical engineers, Surrey Grove, Norwich) have dissolved partnership. Mr. Procter will attend to debts.

Messrs. W. T. Burbey and H. A. Hutton (Burbey & Hutton, electrical engineers and manufacturers, 57B, Hatton Garden, E.C.) have dissolved partnership. Mr. Burbey will attend to debts.

Messrs. A. J. Fippard and C. J. Cooper (Fippard & Cooper, electrical engineers, Albert Road, Bournemouth), have dissolved partnership. Mr. Cooper will continue the business, and attend to debts.

Liquidation Notice.—A meeting of the Universal Electrical Fittings Company will be held at the office of Messrs. G. Franklin & Co., 18, Norfolk Row, Sheffield, on March 28th, at noon, to hear an account of the winding up from Mr. G. S. Greening, the liquidator.

Condensing Plants.—Messrs. Cole, Marchent & Morley, of Bradford, have issued a small pamphlet describing their standard surface condensing plants, with pumps driven by steam, electromotors, or belt. In cases where the space for the storage of water is limited the condensing plants are combined with evaporative condensers or water-cooling arrangements. There are several good illustrations of plant supplied by the firm, such as Bradford Corporation Electricity Works electrically driven centrifugal pumps, and the surface condenser and air pumps at the same station. An article by Mr. H. W. Morley on "Surface Condensers, Air and Circulating Pumps for Electricity Works," is reprinted from a contemporary. The list is a neat production.

A Directory for Exporters.—The Export Merchant Shippers' Directory for 1898, has been published by Messrs. Dean and Co., of 160A, Fleet Street, E.C. It has now reached its thirty-third year of publication, and has increased in size, until it now has nearly 1,300 pages. The contents are divided into three sections, viz., the Export Section, giving a complete list of the British exporters, with the names of their respective trading ports, and the class of goods shipped; the Trade Mark Section; and the Manufacturing Section embodying a list of traders who manufacture principally for export. There are separate sections for the various towns, Liverpool, Bradford, London, and so forth, and under these the names of exporters are given in alphabetical order. The extracts from the consular reports given under the title, "Notes on Trade," has been enlarged in the present edition by the insertion of some of the principle South American Republics, where the competition with British trade is especially keen.

Electric Drill.—On 17th inst. trials of a new electric drill were made on board the White Star steamer, *Nomadic*, at Liverpool. The Boiler Makers' Society lodged objections to its employment.

Electric Organs.—From the *Musical News* we learn that the Hope-Jones Organ Company has received an order for a large organ for St. Michael's Church, Chester Square. The instrument is the gift of a member of the congregation, and is to cost over £2,000. It will be fitted with all Mr. Hope-Jones's latest tonal and mechanical improvements. A new electric organ has also been ordered from the same firm for Ambleside Parish Church, at a cost of £1,000.

Electric Welding.—At a conversazione held at Finsbury Technical College on Friday, 18th inst., the Electric Welding Company, Limited, exhibited an automatic welding plant and a very fine collection of samples welded by their (the Thomson) process, including railway coupling links (lent by the Lancaster Railway Carriage and Waggon Company, Limited) and a complete collection of cycle parts.

Kaye v. the Croydon Tramways Company.—In the Court of Appeal on Wednesday, before the Master of the Rolls, Lord Justice Rigby and Lord Justice Vaughan Williams, the hearing was resumed of the appeal of the Croydon Tramways Company from an order of Mr. Justice Kekewich, who had granted an interim injunction restraining the carrying into effect of an agreement for the sale of the undertaking to the British Electric Traction Company. We have already referred to the case in the Electrical Review. In his judgment the Master of the Rolls said that the appeal succeeded to a certain extent, and he thought the right course to adopt would be to discharge the order of Mr. Justice Kekewich, and to grant an injunction to restrain the defendant company from carrying this agreement into effect until duly sanctioned by the shareholders of the Croydon Company at a meeting duly convened for that purpose. If they chose upon proper notice, and understanding what they were about, to ratify the contract they were at liberty to do so, but it would not be right to allow this agreement to stand until that had been done. The costs of the original plaintiffs and defendants would be costs with the action, and the costs of the purchasing company would be their costs in the action. Lords Justices Rigby and Williams concurred.

Lists.—Messrs. P. C. Middleton & Co., of Aberdeen, have sent us a neat pamphlet which they are circulating, setting forth the advantages of electric over gas lighting, and giving general statements for the benefit of those contemplating the use of electric motors, electric heating and cooking apparatus, &c.

Messrs. Laing, Wharton & Down's new list of "Whardown" track tools gives illustrations and prices of track drills for drilling bolt holes, tie holes, and electric bond holes, rail saws for cutting rails quickly and accurately, and lifting jacks. These devices are being introduced for economising time and expense in track work—especially in connection with electric tramways—and at the same time considerably increasing the quality.

Messrs. Ball, Wylde & Co., of 9 and 10, Fenchurch Street, E.C., have taken up several agencies for American pumping machinery, turbines, steam and electrical machinery, &c., and have also been appointed sole agents for Great Britain by Eugen Seeligmann, of Köln a. Rh. Hansaring. We have before us a catalogue, printed in German, of the firm's manufactures in the way of electrical accessories. Prices and numerous illustrations are given of lampholders, switches, lamps, plain and fancy brackets, electroliers, insulators, casing, and a great variety of small fittings and articles.

Messrs. Handley & Shanks, electrical and general engineers, of Cork, Dublin, and Limerick, have sent us their list of electric light engines, coupled to dynamos, also gas and oil engines for electric lighting, Waverley turbines, "Taunton" dynamos, electric motors, Jandus lamp, and the improved glow lamps.

London Office.—Messrs. Henry J. Rogers & Co., of Watford, have just opened branch offices in London at 4, Bloomfield Street, London Wall, E.C. Mr. H. J. Spencer is the manager for the London district.

New Zealand Electrical Syndicate, Limited.—A petition was brought before Mr. Justice Stirling in the Lord Chancellor's Court on Wednesday for the reduction of the capital of the New Zealand Electrical Syndicate, Limited. Mr. Carson explained that the case was before his Lordship before Christmas, and was adjourned. His Lordship had expressed the wish to see some of the witnesses whom he had examined. After this he had thought proper to direct reference to an expert on certain points. It was suggested that terms might be suggested for this reference. Counsel now brought the terms before his Lordship. After counsels' speeches, his Lordship ruled that an expert electrician should be appointed as referee, and that before making his report he should hear both sides. Perhaps it would be desirable to put that direction in the order for the guidance of the referee. Counsel thanked his Lordship for his assistance in the matter, and agreed on the terms of reference of the matter to an electrical expert.

Photographic Exhibition.—The International Exhibition at the Crystal Palace, 1898, will be opened by the Prince of Wales, on Monday, April 25th—not Wednesday, April 27th.

Sell's Press Directory.—*Sell's Dictionary of the World's Press* for 1898 is before us. As usual, it is a very bulky publication, of about 1,200 pages. As the title denotes, information is given regarding the newspapers, technical journals, magazines, &c., of home and foreign countries. The newspaper man finds much of interest and utility in this directory. Not only is he informed on matters affecting national and international trade, tariffs, treaties, &c., but he has placed before him an anecdotal history of journalism, some important notes by Dr. Gordon Stables on how to keep in health, and a note of the year's events in the newspaper world. The newspaper, as an investment, and the life of the foreign correspondent, are matters which have an interest for those not connected with the journalistic profession.

Workmen's Compensation Act, 1897.—The *Western Mail*, Limited, has issued a fifth edition, revised and enlarged, of Mr. M. Roberts-Jones's handbook on the above Act. The price is 2s. 6d.

The Yorkshire College, Leeds.—The twenty-seventh annual report, 1896-7, of this college, has been issued. It gives details of the classes held and lectures given in various subjects, along with the average attendances, and notes on the financial progress.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The electric lighting accounts for last year show that the income amounted to £5,707 12s. 5d., and after deducting working expenses, there was a balance of £3,111 0s. 7d. That sum had been applied—In paying interest on mortgages and loans, £1,150; in writing off as depreciation on plant, £1,024; carrying to sinking fund, £767; and leaving a surplus (carried to the reserve fund) of £169 5s. 2d.

Messrs. P. C. Middleton & Co., of Aberdeen, have been entrusted by the Town Council with the contract for the lighting of the Municipal Lodging Houses. There will be 300 lights.

Barnsley.—Mr. T. C. Miller has been instructed by the Town Council to report on electric lighting, and if such report is satisfactory, he will later design and superintend the work, subject to the approval of Mr. Bromley Holmes.

Basingstoke.—The Town Council recently referred to a special committee a suggestion to apply for electric lighting powers.

Bedford.—The electric lighting accounts just submitted show as follows:—By sale of current at 6d. per unit, less bad and doubtful debts (£12 19s. 1d.), £3,200 4s.; by sale under contracts, £13 15s. 6d.; rental of meters, £110 3s. 2d.; by public lighting to December 31st, £1,391 13s 5d.; miscellaneous receipts, £2 8s. 11d.; total, £4,718 5s.; balance carried to net revenue account, £1,593 7s. 1d. The general balance sheet shows:—To capital receipts, £39,175 11s. 6d.; to sundry creditors, £165 2s. 8d.: to balance due to treasurer (less cash in hand, £25), £10,348 15s. 8d.; total, £49,689 9s. 10d.; by capital expenditure, £46,389 19s. 11d.; sundry debtors for current and meter rents, £1,890 19s. 11d.; net revenue account—balance at debit thereof, £1,200 4s. 6d.; stores on hand, December 31st, £208 5s. 6d. If the demand continues to increase, reductions will be made in the charges at the beginning of next year.

Brighton.—The Lighting Committee recommends that Montpelier Road and the north part of Preston Road, from Stanford Avenue to the Drive, should be lighted by arc lamps instead of incandescent, as at present, at an increased annual charge of £400.

Broughty Ferry.—The Police Commission has appointed a sub-committee to collect information *re* electric lighting.

Buxton.—Prof. Kennedy has submitted his report on electric lighting, and his estimate for the proposed municipal plant is £18,000.

Calcutta.—The Secretary of State for India recently sanctioned the appointment of an electric lighting inspector for Calcutta.

Cardiff.—The Lighting and Electrical Committee considered last week the electrical engineer's report on the condition of the cables and mains. He stated that the renewal of the cables for the arc lights, which should be carried out at once, would cost about £400. It was resolved to invite tenders for the supply of new cables.

Chester.—The minutes of the Electric Lighting Committee, which have been approved, show that a reduction to consumers of the light might be made for the current year to 5d. per unit, and for motive power to 3d. per unit.

Crieff.—The electric lighting scheme put forward by Mr. Yorke has been further remitted back to a committee of the whole Council for further consideration.

Edenbridge.—The *Kent Messenger* says that a scheme is on foot to form a company to light the district electrically. It is estimated that £2,500 is required.

Edgbaston.—St. Augustine's Church has just been fitted up for electric lighting by Messrs. Veritys, to plans and under the supervision of Messrs. Henry Lea & Son. High voltage lamps are used, and they are arranged around the capitals of the pillars.

Edinburgh.—The Electric Lighting Committee has recommended the supply of watertight chambers for the underground switching apparatus. The Committee also recommends the laying down of a new "feeder" from Dewar Place along Grove Street, and on to Merchiston (cost, £1,400).

The Embankment Lighting.—The London County Council last week adopted a supplemental estimate of £3,300 for the electric lighting of the Embankment. An estimate of £22,000 was previously adopted.

Faversham.—The Town Council will not sanction Mr. McCreel's proposal to apply for a provisional order for electric lighting, and they state that when the time comes they will do the work themselves.

Glasgow.—The Electricity Committee submitted to the Corporation last week reports from the tramways engineer, the assistant electrical engineer, and the lighting inspector on the subject of lighting the Springburn tramway route. The assistant electrical engineer recommended that the mains should be immediately laid down for supplying current for private purposes to consumers along the line of Parliamentary Road to Springburn, and in the same trench a cast-iron pipe to carry arc lighting cables. He reported that the cost of supplying and laying down the feeders and network necessary for private lighting would be about £12,566, and the arc lighting mains £1,446, making a total of £14,012. That is if both were laid at the same time; but if street lighting alone were arranged for, the cost would be £7,022, and the cost of re-opening the trench and laying mains, &c., later on for private lighting would be £9,525; total, £16,547. The first course would, therefore, show a saving of £2,535, and the corporation approved of this scheme, and the work will go forward. The arc lamps will, with a few exceptions, be suspended from the poles on both sides of the route. There will be in all 104 lamps required. Certain designs and estimates submitted by Messrs. W. McFarlane & Co. have been accepted for bases, brackets, &c. The cost for current is estimated at £18 per lamp per annum.

Grimsby.—The Council has confirmed the Lighting Committee's recommendations to ask Prof. Kennedy to report on electric lighting.

Hackney.—The Vestry, after playing with the electric lighting question for the past few years, has just considered a number of proposals submitted by parties willing to take over the provisional order. Among those who made offers were Messrs. C. & A. Sax, Imperial Electric Lighting Company, Siemens Bros. & Co., Laing, Wharton & Down, Electric Extension Syndicate, County of London and Brush Provincial Company. The Electric Light Committee, after considering the various proposals, reported that the scheme submitted by the Electric Extension Company, Limited, covered all the points which the Committee desired to see included. "They offer to collect, destroy, and dispose of the dust at 4s. per ton, to supply public and private lighting at 3½d. and 5d. per unit respectively, and for power purposes only at 2½d. per unit. They satisfied us," say the Committee, "on searching and careful questioning, that they were able to undertake the work and carry it out promptly. They are practically manufacturing firms of the highest standing (the British Insulated Wire Company and Ferranti, Limited); and they were able to show us, from contracts actually carried out by them for more than 100 public bodies and lighting companies, that their experience in dealing with such matters is of a very wide and satisfactory character. No other company tendering impressed us with anything like the same confidence as the representatives of this company did. They undertake to deposit £5,000 with the Vestry—a guarantee for the carrying out of the work at 2½ per cent. per annum. They further undertake to pay the Vestry £500 towards their expenses in obtaining and transferring the order." It is estimated that this will mean a saving of £5,047 per annum to the parish in the collection and disposal of dust. The Vestry has rescinded its previous resolutions, and the Electric Extension Company's scheme will come before it again in a few days.

Hammersmith.—The Vestry has decided to construct two new sub-stations, one in Lime Grove, Uxbridge Road, and the other in St. Stephen's Avenue, Goldhawk Road; £150 is to be expended upon finishing and furnishing the electricity works' offices.

Hampstead.—The Finance Committee has recommended the Vestry to apply to the London County Council for permission to borrow £50,000 to meet the expenditure on the electric lighting capital account.

Harbour Lights.—The Clyde Trust and the Corporation Electricity Department have been conferring as to the lighting of the harbour by electricity. The question was remitted to the officials of both bodies, with special reference to the illumination of the Prince's Dock.

Kensal Town.—The Chelsea Vestry will oppose the Metropolitan Electric Supply Company's scheme to lay mains in Harrow Road unless the company undertakes to supply electricity for Kensal Town at 4d. per unit.

Kingswinford.—The District Council has resolved to make application for a provisional order.

Leamington.—Mr. Hammond has reported to the Electric Light Committee *re* electric lighting, and he advises that it would be to the interests of the Corporation to arrange that the works of the Midland Electric Lighting Company should continue their operations until the whole of the present consumers are transferred to the new mains. Mr. Hammond reports that with an installation of 15,000 lights at 6d. per unit, there would be a profit of £3,000, sufficient for interest and sinking fund, on £50,000 capital.

Lewisham.—The Great Western Electric Light and Power Company has followed up its previous letters to the Board of Works, by saying that it is prepared to undertake the destruction of dust at cost price, guaranteed not to exceed 1s. 6d. per ton; and, in connection therewith, to take over the dust destructor recently erected, at the price paid by the board to the makers for it, and work it at once, pending the erection of electric supply works, when the combined operations would be carried on. The company also propose to introduce the Brighton system. The public streets would be supplied with 16 C.P. lamps at a cost of about 33s. 4d. per annum.

Liverpool.—The electrical engineer (Mr. Holmes) has reported that during the month of January 62,681 electric lamps, equivalent to 16 C.P., had been supplied from the Corporation mains for private lighting, and 7,924 for Corporation lighting. This showed an increase of 2,944 for the month.

Luton.—The Electric Light Committee has discussed the report by Mr. Snell on electric lighting at great length, but considers that further information should be obtained from other towns before the matter is decided. A deputation is to visit several places. Application is to be made for an extension of the provisional order from June 27th, 1898, for 12 months.

Manchester.—A Local Government Board inquiry was held on 15th inst. regarding applications by the Corporation for loans for various purposes, including £16,000 for electric lighting. Alderman Higginbottom gave some details of the undertaking.

Mexico.—The Dresdner Bank communicates that, according to telegraphic advices received from Mexico, the central station of the Mexican Electric Works, Limited, has been so far advanced that the lighting of the City of Mexico was commenced on the 14th inst., and proved a complete success. The installations for the private lighting and the supply of electrical power are making rapid progress, and it is anticipated that these parts of the works will be opened in course of the summer.

Morecambe.—At the last Council meeting there was a long and somewhat heated discussion with regard to a site for fixing a refuse destructor in connection with the electric light generating station.

Morley.—The Corporation are wanting an electrician-in-charge and a junior. See our "Official Notices."

Motherwell.—A deputation has inspected the Whitehaven electric lighting plant, &c.

Newington.—The Vestry decided last week to proceed with the electric lighting scheme, of which plans and specifications had been submitted by Messrs. Kincaid, Waller & Manville. Application is to be made to the London County Council for a £40,000 loan.

Poplar.—The Board of Trade has been asking the Poplar Board what it proposes to do with its electric lighting order. The County of London and Brush Company had been corresponding with the Board of Trade on the matter. The Poplar Board has now decided to put its order into force at once over the compulsory area.

Rhyl.—Mr. Dale recently appeared before a committee to ascertain their views as to proceeding with the electric lighting of the lake, &c. The question was deferred for the present.

Shoreditch.—At the Vestry meeting held on 15th inst., Mr. Kershaw, chairman of the Electric Lighting Committee, informed the Vestry that an accident occurred at the electric lighting station on the previous Saturday, which resulted in the district being plunged into darkness for a while. Fortunately it was not attended by any loss of life or injury to limb, although the explosion was of a serious nature. By some unexplained reason a small quantity of water—probably condensed steam—found its way into the cylinder of one of the engines, which burst, doing about £300 worth of damage. The whole cost of the damage, Mr. Kershaw explained, would be borne by the contractors, and a further report would be presented.

South Shields.—The Board of Guardians have appointed a Committee to consider the question of electric lighting for the whole of the workhouse.

Swansea.—The disposal of the tramways and the introduction of an electrical company into the town have, according to a local paper, caused a stir in corporation circles in Swansea. A sub-committee recommends that action be taken at once to carry out the provisions of the electric lighting provisional order.

It is understood that the Council has decided to proceed with the provisional order, and is consulting Mr. Manville on the subject.

Winchester.—The City Council, after receiving Mr. Ruthven Murray's report on the Electric Lighting Company's scheme, has informed the Board that it has no objection to the proposal.

Yarmouth.—The income in January from the electric light was £531 5s., of which private consumers furnished £426. After meeting the costs of production, there is a surplus of £316 12s., out of which £190 has to be deducted for capital repayments and interest charges, making the monthly net profit £126 12s. There are now 258 customers, using 11,993 lamps.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Bournemouth.—By 13 votes to 8 the Bournemouth Town Council has again resolved to oppose the two electric tramway schemes which have been on foot for some time.

Bristol.—The Sanitary Committee have held several special meetings to consider the Parliamentary Bills of the Bristol Tramway Company with regard to the extension of their system and the use of electric power, have submitted to the company a statement of the conditions on which they will advise the Council to allow the extensions and the use of electricity. The committee abandon their former demand that the electricity shall be taken from the Corporation supply, but raise several other points which may prove subjects for debate. The company are required to agree that no employé shall be employed for more than 60 hours a week. Lines on which electric traction is to be used are to be specified and the system stated. The Corporation are to have the right to, but not to be compellable to purchase the proposed power station; if the power station be purchased, the company are not to have the right of jointly using it for working tramways not purchased by the Corporation, nor are they to have the right to use posts, rails, &c., of tramways purchased for conveying energy to lines not purchased. The Corporation are to retain powers with regard to the position of posts and overhead wires and other matters as in the 1894 Act. The company are not to supply electric current to other companies or persons within the city. The Corporation may use the company's posts for electric light purposes. The company are not to be entitled to require the Corporation to supply them with electricity. No alteration is to be made in the dates at which the Corporation's power of purchasing existing tramways will arise, and the date at which the Corporation may purchase the power station and proposed extensions are to be the same as for the present horse tramways. Additional capital is to be put up to auction instead of at present being issued to existing shareholders at a price determined by the company. Safe arrangement is to be made for payment to the Corporation of an annual sum and for reduction of fares. As to this last condition, no suggestion is made as to the sum or what reductions are desired.

Mr. Faraday Proctor, the Corporation electrical engineer, is to visit Liverpool, Manchester, Leeds, Bradford, and Sheffield, in search of information to lay before the Bristol Sanitary Committee to enable them to make up their minds on the proposals of the Bristol Tramways C. mpany.

Central London Railway.—At the Sheriff's Court, Red Lion Square, Holborn, last week, Mr. Burchell and a special jury had before them a claim by the trustees of the late Frederick J. Blake, against the Central London Railway Company for £539 for the purpose of repairing the residence, No. 2, Marlborough Gate, Hyde Park, which is alleged to have suffered damage by subsidence due to the works of the railway company. It was alleged that the house in question had been structurally injured by the works of the company either primarily or by reason of the bursting of a water main, owing to the tunnelling operations. On behalf of the railway company Sir Douglas Fox and others gave evidence. It was contended that the system of tunnelling with the Greathead shield prevented any possibility of injury to adjacent buildings, and that the subsidence must have been caused by the bursting of the water main owing to internal pressure. The jury returned a verdict for the railway company on the ground that the damage was done by the bursting of the water main, for which the railway company had not been shown to be in any way responsible.

Dublin.—A question having arisen between the Council and the three United Tramways Companies as to a power station at Ringsend, it is now stated by the *Irish Times* that an agreement has been arrived at by which "In consideration of permission being granted by the Corporation to the companies, or any of them, to electrically connect their system of tramways with the company's proposed generating station at Ringsend Road for the working of their system of tramways, or any portion thereof, in connection with their lines within the City of Dublin, the said three companies shall undertake not to employ the electrical current for any purpose other than the haulage of their cars and the lighting of them, and of the standards or posts wherever it may be found necessary to do so, within the City of Dublin, without first receiving the sanction of the Corporation in writing."

Dublin and Lucan.—At a meeting of the Dublin and Lucan Steam Tramway Company it was resolved to issue debenture stock and preference shares for the purpose of providing the electrical equipment for the lines.

Dudley.—It is stated that the Electric Traction Company has accepted a tender for converting the steam tram line from Dudley to Stourbridge into an electric line, and the work is to be executed within six months from the date of its commencement.

Edinburgh.—A proposal was before the Lord Provost's Committee last week for the construction of an electric tramway from Preston Street *vid* Dalkeith Road and Niddim, to Portobello, returning by Meadowbank and Waterloo Place. The matter was deferred.

Kirkcaldy.—The British Electric Traction Company recently wrote stating that it would be willing to take up the question of electric tramways for Kirkcaldy. The Town Clerk reported that a representative of the company had visited the town.

Leeds and Bradford Light Electric Railway.—We have on several occasions given brief notes on the progress of this scheme which, it will be remembered, is being promoted by Power and Traction, Limited, who propose connecting the two towns by means of an electric tramway on the overhead trolley system—an inter-urban line over the main highway. The population of the districts affected is over 700,000, and five district councils are interested in the scheme. The proposals came before the Light Railways Commissioners (Mr. G. J. R. FitzGerald and Col. Boughey, R.E.) at the Leeds Town Hall on 17th inst., and there were present to oppose representatives on behalf of the Leeds Corporation, Bradford Corporation, the Midland Railway Company, and the Great Northern Railway Company. With such extensive opposition it might reasonably have been expected that it would go hard with the scheme. Mr. Arthur Graham Hopkins, electrical engineer, of Westminster, produced the plans of the proposed line, which had been prepared under his direction. He stated that for 15 years he had had considerable experience in the construction of light railways. The gradients involved in the present scheme were generally easy, with one exception at Stanningley, but this was trifling to what could be done by electric traction. The object of the project was to afford more convenient and cheaper facilities for intercommunication. Mr. W. N. Stewart, of Westminster, one of the founders of the American Association of Electrical Engineers, whose experience comprised 13 years with Mr. Edison, of New York, also gave evidence in support of the scheme, which he said would have an important effect in increasing the prosperity of the districts passed through. His experience had proved to him that a multiplicity of administration operated against the success of a scheme of this description. At the close of the inquiry the chairman said: "We consider the utility and convenience to the public of this proposed light railway to be established. But the objections of the two corporations to a private company undertaking the work and management within their respective areas most certainly require very serious consideration. In the absence of Lord Jersey, we shall not make any further statement or express any further opinion to-day, but we trust that the result will be a resumption of negotiations. If it is desired, we shall be very happy to do anything in our power to facilitate a settlement." It is believed that an electric tram service at short intervals and low fares is a very important improvement on the present railway service. The decision of the Commissioners in this case is of considerable importance. It shows that they are not disposed to let schemes fall through unless there is good reason, and their offering to aid the parties in arriving at a settlement is very satisfactory.

Light Railways.—In the House of Commons on Monday, in reply to Mr. Bainbridge, Mr. Ritchie said that up to the present time 16 orders had been made by the Light Railways Commissioners, and submitted to the Board of Trade for confirmation. Of these, four had been confirmed by the Board of Trade after modification, and five others would shortly be ready for confirmation. One order had been remitted to the Light Railways Commissioners for further consideration, and in the case of the remaining six orders the time for lodging objections had not yet expired. None of the undertakings authorised made any claims for financial assistance from the Treasury or local authorities. Grants, however, had been provisionally sanctioned by the Treasury in cases which were still under the consideration of the Light Railways Commissioners.

Liverpool.—The Tramways Committee has appointed a deputation to visit Hamburg for the purpose of inspecting the tramways, and the methods of working the service and the management of the workshops.

Middlesboro'.—The British Thomson-Houston Company, Limited, is pushing forward the construction of the electric tramways. The poles are being rapidly erected. The trucks for the car bodies are expected to arrive in this country by the end of the month from America. The car bodies (being constructed at Birkenhead) are also expected to be finished shortly. The three multitubular boilers for the depôt in Bridge Road, Stockton, are being rapidly fitted up in position in the power house. The overhead wire has already arrived, and is on the ground ready to be put up, but in the meantime the company are waiting for brackets.

Nottingham.—A deputation has visited Bristol to inspect the electric tramways and the power station. It is understood that as a result of this visit the deputation will recommend the adoption of overhead electric traction throughout Nottingham.

Paisley.—An extraordinary meeting of the shareholders of the Paisley Tramways Company was held in private last week, when a resolution was adopted ratifying an agreement between the company, Messrs. A. and J. Faill, Robertson Street, Glasgow, and the British Electric Traction Company, Limited, the effect of which will be to empower the last-mentioned body to work the present tramway system by electric traction, and to carry out alterations and extensions.

Peterborough.—A local paper refers to a proposed electric tramway scheme which is being promoted for the district by a syndicate.

Salford.—The report of the sub-committee on electric traction recommends that the Council should undertake the future working of the Salford tramways on the electric overhead wire system, and that the current for working the cars should be provided by the Electric Lighting Committee. By 33 votes to 1 the Council has instructed the committee to prepare estimates of the cost of carrying out a scheme put forward for Salford. The committee's report contained the following:—"In reference to the tramlines to

Eccles, Patricroft, Swinton, and other places reached through Salford, there would be no difficulty in providing electric power to work these lines from the power station required for the Salford lines; or electric power might be supplied from any electric power station within those districts. The reconstruction of the lines to adapt them to this system could either be undertaken by their respective owners or by the Salford Corporation under special agreements. All these points presented no mechanical or electrical difficulties, and no doubt could be arranged between the several authorities on terms mutually advantageous. In order to give an approximate idea of the structural work required for this proposed working of the Salford tramways, it must be remembered that most of the existing tramlines in the borough had been in use for many years; the rails were not of the strength found most suitable for either horse-car or electric-car work, and therefore it would be requisite to provide new rails throughout, except as to some lines very recently relaid. In re-organising the tramway system it would be well to change all the existing single track routes to double tracks, laying parallel lines in adjacent streets wherever the streets were too narrow for a double track, with side spaces for cart traffic. Some additional lines of tramway, in extension or in deviation of existing lines, were also advisable. The total result, according to a plan provisionally prepared, would be that in place of their present 8½ miles of double lines and 3¾ miles of single line and crossing loops, a total of 20¾ miles of single track, they would have 12·8 miles of double track, 4·3 miles of single track used like double track in parallel streets, and 2·5 miles of single track with crossing loops—a total of 32·4 miles of single track."

Stoke-on-Trent.—The Parliamentary Committee has recommended that the Town Clerk write to the British Electric Traction Company, and to the North Staffordshire Tramways Company urging them to carry out the arrangements which were come to at the time when the Tramways Extension Order (1896) was passed, and inform them that unless they carried out their several obligations the Corporation would take such steps as they might be advised to enforce the same.

Swansea.—Shareholders in the Swansea Tramways and Improvements Company have been notified that a meeting to confirm the sale of the tramways will be held to-day, and adds that the directors have entered into a provisional agreement for the purchase by the British Electric Traction Company, Limited, of the whole of the undertaking, property, and assets of the company, on terms which they believe will be acceptable to the shareholders. The purchase price will, if this agreement be carried into effect, provide for the payment of £5 per share to the holders of ordinary shares of tramway capital, and of £10 for each preference share.

The Power Distributing Schemes.—In the opposition to the Bill of the General Power Distributing Company for electric lighting powers, Bakewell will join with Belper, Matlock Bath, Mexboro', North Darley, and Swinton.

Yarmouth.—The Yarmouth and Gorleston Tramway Company are negotiating for the purchase of the Yarmouth 'Bus Company's undertaking, including horses, vehicles and premises, their intention being to make the Yare side stables, which are situated between Yarmouth and Gorleston, a station for the generation of electricity, in order that they may be able to run electric trams between Yarmouth and Gorleston.

York.—The chairman of the York Tramways Company told the shareholders last week that they looked forward to being able to give a better service to the public by the application of electricity, without materially increasing their expenses, and they hoped that the Corporation, with whom they were in negotiation, would meet them fairly. No progress had been made in the matter, because the Corporation had such difficulty in making up their minds with regard to the electric light.

TELEGRAPH AND TELEPHONE NOTES.

Australian Cable Delays.—A joint deputation from the Melbourne Chamber of Commerce and the Melbourne Chamber of Mines has waited upon the Hon. J. G. Duffy, the Postmaster-General, and strongly protested against the delays to which cable messages were liable. The deputation furnished evidence that these delays were almost entirely traceable to the South Australian lines. Mr. Duffy, in the course of his reply, announced that the Eastern Telegraph Extension Company had offered to extend the proposed new Cape cable from the Cape to Mauritius, and thence to Albany and Adelaide, provided the Australian Governments would agree to renew their present subsidy of £32,400 per annum for 20 years.

Replying to Mr. Hogan, in the Commons last week, Mr. Chamberlain said there had been no interruption in our cable service with Australia during the last two months, but the land service had been several times interrupted. He had nothing to report as to any alternative service, which was not being pressed at the present time by any colony.

Hawaiian Cable.—Mr. James A. Scrymser, president of the Pacific Cable Company, appeared at Washington, on January 18th, before the House Committee on Interstate and Foreign Commerce to advocate a contract with the United States, whereby the company would transmit all official messages for $175,000 a year, for 20 years, from San Francisco to Hawaii, China, and Japan, with a proposition to extend it to Australia for $75,000 additional per year. He said that during the Venezuela trouble it had cost the Government $5,000 for one diplomatic message, and no one knew what the Government's aggregate expense was in this connection. According to a New York exchange he said that it would take 8,000 miles of cable from San Francisco to Honolulu.

L.C.C. and Telephone Matters.—A statement by the Highways Committee on the telephone service of the National Company was before the Council on Tuesday. The matter will come up again before the first meeting of the new Council.

The Telegraph Service.—The Council of the Associated Chambers of Commerce recently requested the Postmaster-General to receive a deputation on the subject of telegraphic communication. The Duke of Norfolk, in reply, says that the Lords of the Treasury have been consulted, and they do not consider it advisable to propose the abolition of the separate account for telegraphs. With regard to the extension of telegraphic facilities in rural districts, his Grace has given the matter special consideration, and the concessions given on the occasion of the Diamond Jubilee were evidence of the desire of the Government for the increase of such facilities. In the course of the year many new telegraph offices have been opened and costly extensions are in hand. The total number of telegraph offices of all kinds now open to the public is 10,432.

Telegraphic Communication between Calais and Dover.—In the House of Commons last week, Mr. Hanbury, in answer to Mr. Cohen and Mr. Stuart-Wortley, with regard to the mail packet from Dover to Calais having left Dover in a storm on November 29th and having had to put back, when a telegram sent from Calais to prevent her from starting had been delayed by having to reach Dover through London, said the delay did not take place on that account. It arose from an interruption caused by the storm with the line between Calais and the French landing station, about six miles off, necessitating the transmission of the telegram by a circuitous route. There was not sufficient traffic to justify the allocation of direct wires between France and Dover or Folkestone. The transmission of the telegram through London did not involve any appreciable delay. The Postmaster-General was considering whether any arrangements could be made whereby the consequences of an interruption to the normal communications would be rendered less serious than on that occasion.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Paramaribo-Cayenne ...	Jan. 27th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Saigon-Hong Kong	Jan. 8th, 1898 ...	...
Emden-Vigo	Feb. 7th, 1898 ...	Feb. 18th, 1898
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Bolama-Bissao	Feb. 19th, 1898 ...	...
LANDLINES.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Costa Rica landlines ...	Feb. 10th, 1898 ...	Feb. 18th, 1898.
Saigon-Bangkok	Feb. 16th, 1898 ...	Feb. 17th, 1898.

Trunk Telephone Lines.—In reply to a memorial of the Associated Chambers of Commerce regarding the irregularities and delays in the trunk telephone service, the Postmaster-General has replied that the department is continuing its efforts to provide a widespread and efficient system; during the period from April 1st to December 31st, 1897, the construction of additional trunk wires, amounting to upwards of 3,000 miles, was undertaken. Some of these have been completed, and others are being rapidly constructed.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—March 8th. The Corporation wants tenders for the wiring of the new police cells, Chichester Street. Electrical engineer, Mr. V. A. H. McCowan. See our "Official Notices" February 18th.

Belgium.—April 1st. The Municipal Authorities of Seraing are inviting tenders for the concession for the supply of electrical energy in the town for public and private lighting purposes during a period of 30 years. Particulars may be had from, and tenders to be sent to, the College des Bourgmestre et Echevins, Seraing, Belgium.

Berlin.—March 15th. The Municipal Traffic Deputation of the Town Council has opened a competition for the construction of several new electric tramways in that city. Exhaustive details concerning this project are contained in the *Elektrotechnische Zeitschrift* of the 13th inst., which mentions that proposals will be received by the Stadtische Verkehrsdeputation Rathhaus III, Berlin, by March 15th.

Blackpool.—March 22nd. The Corporation wants tenders for a tubular boiler, superheaters, condensers, rectifiers, boosters, transformers, lead-covered cables, arc lamps and pillars. Borough electrical engineer, Mr. R. C. Quin. See our "Official Notices."

Carlisle.—February 25th. Tenders are being invited for the erection of the central station buildings in James Street. City engineer and surveyor, Mr. H. C. Marks, 36, Fisher Street.

Coventry.—March 8th. The Electric Light Committee wants tenders for the supply and erection of engine house, separate exciting and surface condensing plant, also pipework, switchboards and instruments for extensions of the municipal electricity works. Consulting engineer, Mr. Robert Hammond. See our "Official Notices" February 18th.

Denmark.—March 12th. Tenders are being invited for the supply of the engines, dynamos, accumulators, &c., required in connection with the new central station at Frederiksberg, near Copenhagen. Tenders to be sent to the Frederiksberg Sporveis-og Electricitets Aktieselskab, Gammel Kongerie, 140, Copenhagen V., from whom particulars may be obtained.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

Glasgow.—February 28th. The Corporation wants tenders for the hire or purchase of dynamos and engines, direct coupled or belt driven, capable of providing 1,100 B.H.P. and spare power equal to 25 per cent. additional, also two rope driven dynamos to run at a speed not exceeding 500 revolutions per minute, and capable of providing 200 H.P. each at a potential of 230 H.P. The plant must be delivered by August 1st. Engineer, Mr. W. A. Chamen. See our "Official Notices" February 18th.

Glasgow.—February 28th. The Corporation wants tenders for the supply of lead covered cables and accessories for twelve months, accumulators, motor transformers, motor driven boosters and switching apparatus. Mr. W. A. Chamen, engineer. See our "Official Notices" February 18th.

Italy.—March 1st. Tenders are being invited by the Municipal Authorities of Cassino (Caserta) for the concession for the electric lighting of the public streets of the town during a period of 30 years. Tenders to be addressed to El Municipio de Cassino (Caserta), Italy. Particulars from ditto.

Italy.—March 2nd. Tenders are being invited by the Municipal Authorities of Piacenza for the establishment of a central electricity generating station in the town for lighting and power purposes. Particulars may be had from, and tenders to be sent to, El Municipio di Piacenza, Italy.

Liverpool.—March 8th. The West Derby Board of Guardians wants tenders for supply and erection of boilers, engines, dynamos, batteries, wiring, &c., for the lighting of the Mill Road Infirmary. Consulting engineer, Mr. T. L. Miller. See our "Official Notices" for particulars.

Northwich.—March 5th. The Weaver Navigation Trustees are inviting tenders for the construction and erection of the necessary electric power plant for lighting and working the new swing bridges at Northwich. Current will be supplied by the Northwich Electric Supply Company. Engineer, Mr. J. A. Saner, M.I.E.E. See our "Official Notices" February 11th.

Pembroke (Ireland).—March 5th. The Lighting Committee wants tenders for the supply and erection of various plant, machinery, &c., for electric lighting. See our "Official Notices" February 18th for full particulars. Consulting engineer, Mr. Robert Hammond.

Roumania.—March 15th. Tenders are being invited by the General Direction of the Roumanian Post and Telegraphs in Bucharest for the supply of 56,000 metres of galvanised iron and steel wire.

Shoreditch.—March 8th. The Vestry wants tenders for the supply of electric cables and sundries, also engineers' tools, ironmongery, &c. See our "Official Notices" February 18th.

Sunderland.—February 25th. Tenders are invited by the Corporation for the supply of various cables, pipes, service boxes and stoneware casings for the year. Borough electrical engineer, Mr. J. F. C. Snell. See our "Official Notices" February 18th.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—March 21st. The Telegraph Department of the Victorian Government Railways is inviting tenders for the supply of alternating current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer Street, Melbourne.

Wallasey.—March 17th. The District Council wants tenders for the supply of engine, alternator, exciter, two Lancashire and one water-tube boilers, and condensing apparatus. Engineer, Mr. J. H. Crowther. See "Official Notices" February 11th.

Warsaw.—The Warsaw Municipality is inviting applications *re* supplying the town with electrical power for purposes of lighting, tramways, &c. Further particulars, says *Daily Tenders*, may be obtained from, and applications to, the President of the town of Warsaw.

Watford.—March 16th. The District Council wants tenders for the supply and erection of various plant for the electric lighting of the district. For details of the seven sections see our "Official Notices" February 11th. Mr. W. C. C. Hawtayne, consulting engineer.

West Ham.—March 8th. The Council invites tenders for wiring and fitting up various buildings, including the Town Hall, police court, Corporation stables, fire stables, &c. Mr. J. Steinitz borough electrical engineer. See our "Official Notices" February 18th.

CLOSED.

Belfast.—The Electric Committee has accepted the tender of Messrs. T. Parker, Limited, to supply and erect a 200-kw. steam dynamo for lighting and traction. A sub-committee is preparing a summary of all that has been done by the Council in the way of investigating the electric traction question.

Bradford.—The Gas and Electricity Committee has accepted the tender of Messrs. Cole, Marchent & Morley, of Bradford, to supply additional condensing apparatus at the new electricity works for £1,600. In view of the complaints regarding meters at present in use, a new style at £2 per meter less is to be adopted.

Leith.—The contract for boilers and accessories for the electric lighting installation has been given to Mr. Geo. Sinclair, of Albion Boiler Works, for £3,313. Messrs. Carrick & Ritchie will supply an 8-ton travelling crane for £240. We have already mentioned that the contract for the engines, dynamos, &c., is in the hands of the India-Rubber Company at £8,844. Mr. W. A. Bryson is the Corporation electrical engineer. The cost of cables and laying same is estimated at about £8,000.

Walsall.—The number of consumers has increased to 102. The following tenders for extension of the plant have been accepted, viz.:—Messrs. Bumstead & Chandler, engine, £910; Thomas Parker, Limited, for supplying a continuous dynamo and a spare armature, £1,160; and Callender's Cable and Construction Company, Limited, supplying and laying on the solid system in a cast-iron trough, three new concentric cables at the price of 19s. 6d. per yard (exclusive of the cost of excavating).

Wimbledon.—The following is a full list of the tenders sent in for the municipal electric lighting scheme:—

BUILDINGS.

	£	s.	d.
Messrs. Manter	2,990	0	0
„ Thomas & Edge	3,261	0	0
„ Lorden & Sons	3,333	0	0
„ Burgess (accepted)	3,388	0	0
„ Wall & Co.	3,578	0	0
„ Buller & Co.	3,790	0	0
„ Jerbury & Co.	3,984	0	0

MACHINERY.—*Section A, Boilers.*

Messrs. Babcock & Wilcox (accepted)	2,482	0	0
The Southern Cross Engineering Company	2,795	0	0
The Haythorn Tubular Boiler Company	3,397	0	0
Messrs. Hornsby	3,505	10	0

Section B.—Condenser and Pipes.

Messrs. Babcock & Wilcox (postponed)	2,681	0	0

Section C.—Crane.

Messrs. Carrick & Ritchie	130	0	0
„ Higginbotham	132	0	0
The Bedford Engineering Company	149	0	0
Messrs. Spencer	152	0	0
„ Babcock & Wilcox	155	0	0
„ Taylor & Hubbard	155	0	0

Section D.—Steam Engine and Dynamo.

The Southern Cross Engineering Company	3,880	0	0
Messrs. Parsons	4,124	0	0
„ Crompton (accepted)	4,181	0	0
The Electric Construction Company	4,368	0	0
Messrs. Easton, Anderson & Goolden	4,575	0	0
„ Mather & Platt	4,639	0	0
„ Siemens	4,690	0	0
The Brush Company	5,170	0	0
The General Electric Company	5,615	0	0
Messrs. Fowler	5,801	0	0

Section E.—Switchboards.

Messrs. Edison & Swan	454	18	0
„ James White	568	10	0
The Electric Construction Company	570	0	0
Messrs. Crompton	621	0	0
„ Siemens (postponed)	692	0	0
„ Sharp & Piper	721	10	0
The General Electric Company	750	0	0
Messrs. Fowler	755	0	0
„ Ferranti	832	0	0

MAINS.

Messrs. Henley & Co. (accepted)	15,792	12	9
„ Glover & Co.	16,127	17	4
„ Callender	16,587	8	4
„ Siemens	17,417	11	3
The British Insulated Wire Company	20,833	19	2
The Western Electric Company	20,950	19	10

FORTHCOMING EVENTS.

1898.

Friday, February 25th, at 6.30 p.m.—The Institution of Electrical Engineers. Students' visit to the Shoreditch electricity supply station. Applications at once to the Students' Hon. Sec. (Mr. S. Grant, 28, St. Mary Abbot's Terrace, W.) as the number will be limited to 20.

At 8 p.m.—The Institution of Civil Engineers.—Students meeting. "The Problem of Train Resistance," by C. E. Wolff, B.Sc., Stud.Inst.C.E.

Sunderland Corporation tenders due to-day.

Saturday, February 26th, at 4 p.m.—Physical Society in the Chemistry Lecture Room, Keate's Lane, Eton College. The Rev. T. C. Porter will describe:—1. A new theory of geysers. 2. A new method of viewing Newton's Rings. 3. Experiments bearing on the sensation of light. 4. A method of viewing lantern projections in stereoscopic relief. 5. Winter observations on the shadow of El Teide, with a new method for measuring approximately the diameter of the earth. 6. Temperature of the water of Niagara.

Monday, February 28th, at 3 p.m.—The Institution of Junior Engineers. Visit to the Westinghouse Brake Company's Works, York Road, King's Cross.

Last day for Glasgow Corporation tenders.

Tuesday, March 1st.—Röntgen Society. General meeting at the rooms of the Medical Society, 11, Chandos Street, Cavendish Square, W., Prof. S. P. Thompson presiding. Paper on "The Photographic Activity and Penetration of Röntgen Rays at Different Vacua," by Mr. J. H. Gardner; other papers by Mr. Wilson Noble and Mr. Hall Edwards. Mr. Isenthal will show some new apparatus.

Wednesday, March 2nd, at 8 p.m.—Society of Arts. "Kites: Their Theory and Practice," by Captain B. F. S. Baden-Powell. Prof. W. Grylls Adams, F.R.S., will preside.

Thursday, March 3rd, at 8 p.m.—Chemical Society, Burlington House. Papers to be read:—"Note on the Preparation of Dry Hydrogen Cyanide and Carbon Monoxide." John Wade, B.Sc. and Laurence C. Panting, M.B. "Production of Some Nitro- and Amido-Oxylutidines." J. N. Collie, Ph.D., F.R.S and T. Tickle. "Production of Some Nitro- and Amido-Oxylutidines, Part II." J. N. Collie, Ph.D. F.R.S. and Miss L. Hall. "The Interaction of Magnesium and Solution of Copper Sulphate." E. Divers, M.D., F.R.S.

Royal Institution. First of a series of five lectures on "Recent Researches in Magnetism and Dia-Magnetism," by Prof. Fleming.

Friday, March 4th, 8 p.m.—At the Westminster Palace Hotel. The Institution of Junior Engineers. Paper on "An Outline of Patent Law and Practice," by Mr. Arthur H. Stanley, Fel.C.I.P.A., Member.

NOTES.

(*Continued from page* 257.)

American Dynamos.—Our friends on the other side have been most active in developing the applications of the dynamo-electric machine. But few improvements have originated in America. The modern dynamo, with all its perfections, is the product of European, and mostly British, science, yet it finds a far greater field of application in the States; and some things, although well known here and not much used, are sometimes promoted in America as novelties, and meet with considerable acceptance. A case in point at present is the introduction of what is called the multi-voltage dynamo, a form of dynamo long ago patented in this country by Kennedy, brought out subsequently by Herr Rothert in Germany, and by Mr. Sayers and Mr. Kingdon in Britain. No doubt our friends will work this style of machine "for all it is worth," but at the same time it is only fair to point out that the construction of machines to give several voltages from one armature and one commutator is well known, its principles and methods of operation are well understood, and in this country, at any rate, any manufacturer is quite free to construct, and use, and sell such machines when they are wanted. In back numbers of the ELECTRICAL REVIEW several references will be found to these multi-voltage or multi-circuit dynamos.

Rail Bonds.—Not long ago we remember coming across a reference by some would-be learned authority in electric traction to the idea that heavy rails are necessary for the new method of traction because large currents are conveyed along them! It is, of course, quite true that 80, 90, and 100-lb. rails are now used where formerly a weight of 45 or 50-lb. was considered enough; but the notion that such an increase is required for improvement of the return circuit is strangely belied by the fact that engineers responsible for electric tramways are satisfied with bonding a 90-lb. rail with two No. 0 copper bonds! Assuming that the capacity of the bonds at any joint does not exceed 25 per cent. of the maximum capacity of rail, a 90-lb. rail would require no less than three No. 000 bonds at each joint. It is evident, then, that rail and bond capacities do not correspond at all, nor is it necessary that they should. The usual rail area is enormous for the current it has to carry, and the trouble as to resistance and waste is not here but at the joints, where insufficient and irregular contacts are, we fear, frequent. A single track of 90-lb. rail has a capacity in area of steel equal to at least 2½ square inches of copper. In the *Street Railway Journal* Mr. E. T. Birdsall touches upon this point, mainly for the purpose of drawing attention to a new type of heavy copper rail bond which he has devised, suitable for soldering to the under side of the rail base. It consists essentially of a number of copper wire horseshoes, placed one above the other to the number of, say, five, with a long flat-footed sort of elliptical base cast on to each vertical series of ends. The whole thing is claimed to be cheap—costing about 6s. put into position—and possessing great flexibility. With 60-foot rails, Mr. Birdsall gives the cost of bonding as £45 per mile, single track.

Different Men, Different Minds.—Some of our contemporaries do not think very highly of the promoting and financing interests engaged just now in the development of electric tramways at various places in this country, and profess to believe that these interests are very largely bent upon making great profits for themselves out of what are to be regarded as speculations instead of investments. We are glad, however, to note that the *Railway World* has a different view of the matter, and in its last issue comments upon this subject much more favourably. Our contemporary considers that so far, with scarcely an exception, every electric traction enterprise has been initiated by genuine investors who have desired to secure an enduring success for a useful industrial undertaking. As a special instance of this praiseworthy type of promotion there is brought forward the Oldham, Ashton and Hyde Electric Tramway, the share capital for which was lately offered to the public and subscribed several times over, and we think from such well based information as has been at our command, that the statements of our contemporary are justified. It is much to be hoped that this happy condition of affairs will long continue, and that we shall not in regard to electric traction see any of the disastrous methods only too common in the early days of horse tramways, when financiers bought or obtained concessions cheaply, sold them at high figures to subsidiary companies, and then left the latter to struggle on as best they could with enormously inflated capital accounts.

Electricity on Warships.—The following letter from "Velox" appeared in Wednesday's *Times*:—

The explosion on board the cruiser *Maine* has startled the world. No doubt it will lead to very full inquiry, but at this inquiry other considerations and tests beyond those which are commonly accepted should be brought into notice. Our modern war vessels are fast becoming threaded by wires, hidden away in every direction. Very large currents of electricity circulate through these wires and also in the dynamos. The common care is to see that all the electrical communications are well insulated, and with good insulation the matter and consideration ends. But ought it to do so? It is well known that insulation has no retarding effect upon induction, and that when large currents are in circulation, or meeting arrest, the induced electricity extends for many feet beyond the insulation. Hence we have only to supply some other material—such, for instance, as a length of wire rope, a length of chain, or even a collection of shell or other metal cases—suitably placed, and a spark may be obtained at many parts of the ship. The thought certainly rises whether these powerful currents ought to be employed on board vessels which carry gunpowder and dynamite. The latter is an unstable compound and may, beside, be affected by these induced charges. It certainly seems to me that our modern warships have as much to fear from these electrical actions as they have to fear from the enemies' shot.

Lectures.—On behalf of the Literary Society in connection with Marylebone Presbyterian Church, a lecture was delivered on Wednesday evening, last week, by Mr. F. Tandy, A.I.E.E., upon the subject of "Electric Waves," with special reference to signalling through space. Numerous experiments, and illustrations by limelight, demonstrating the possibilities of telegraphic signalling between two points without connecting wires, were shown by Mr. Tandy, assisted by Messrs. G. E. and R. J. Taylor. Interest was added to the lecture, by some actual recorded signals being on view, that had been transmitted recently between Alum Bay (Isle of Wight) and Madeira House, Bournemouth, an approximate distance of 14 miles, which had been kindly supplied for the lecture by Signor Marconi. Mr. Tandy had the loan of apparatus from W. H. Preece, Esq., C.B., engineer-in-chief at the Post Office.

Before the Shipley Textile Society on 14th inst., a paper was read by Mr. A. R. Foster, of Bradford, on "Will Electricity Advance the Loom?"

Before the Glasgow Technical College Scientific Society on 12th inst., Mr. E. H. Judd read a paper on "High Speed Engines for Electric Lighting." He gave interesting figures regarding the engines employed in London and the provinces. Taking London with 19 electricity stations, of 16 of which the lecturer had information, containing 176 engines, there were 116 Willans, 10 Belliss and 18 other types, giving a total of 32,182 H.P., or 70 per cent. of the total horse-power in these stations, supplied by high speed engines. In the provinces, of 604 engines in electric light stations, 357 were high speed.

Prof. S. P. Thompson lectured on "Electric Motive Power" at Carpenters' Hall, E.C., on Monday last week.

Under the auspices of the Dundee Institute of Engineers, Mr. A. G. Seaman lectured at Dundee, on 18th inst., on "Underground Systems of Electric Traction."

Electricity in Municipal Engineering. — Mr. R. Bowens, writing to the *Electrical World*, finds fault with the power department of municipalities. He finds, especially in western towns, that water supply is often obtained from distributed wells each provided with its own steam plant of the direct acting and therefore wasteful description. In place of so many separate plants and attendants he would collect all power at one central station with a minimum of attendance, and distribute therefrom electrical power to the outlying stations to drive the pumps. In many towns, especially where there is some water storage, the pumping can be chiefly done by day so as to provide load for the lighting plant of a municipal light station and a regular economical rate of work can be maintained. Electricity is also recommended for sewage sterilisation on the Hermite or Woolf systems. In one case, for a population of 30,000, the power required was only 15 H.P., and the cost per annum barely 13d. per head, and this would be halved if the electricity came from one central station. The necessity of regularity in burning refuse makes very convenient the use of power in pumping, so as to maintain a constant demand for steam the whole 24 hours through. For small towns, in which many things are municipalised, there is much to be said for the author's suggestions. Indeed, in London, there might be much done to economise fuel and expense all round, could men only agree to mutual economies. Could one only see all the power generation of London in the sweep of one's eye, there would be visible many men banking up boiler fires and doing their best to check steam raising. Others would be equally busy trying to keep steam against a heavy draught, there would be seen electrical station boilers lighting up at night and pumping stations shutting down, and generally about twice the fuel burned that need be, and quadruple the labour expended. There would be seen clouds of steam blowing to waste in the air, and thousands of houses half warmed by extravagant laborious fires that might be nicely warmed from waste heat. In fact, no one realises the economy that would be possible were municipal authorities half alive to their duties and responsibilities. Merely for pumping, sewage treatment and street lighting, our author considers that a refuse burner, perhaps assisted with good fuel, would find a fairly steady load for every hour of the twenty-four.

Institution of Mechanical Engineers.—On the second evening of the recent meeting of this Institution held in London, Mr. Johnson occupied the chair, and the proceedings were opened by Sir Douglas Galton moving a vote of thanks to Mr. Bache on his retirement after many years' service to the Institution. The speaker referred, says *Engineering*, in feeling terms to the devotion to his duties which, for so long a period, the late secretary had displayed, and he felt sure that the good wishes of all members of the Institution would follow Mr. Bache in his retirement and well-earned rest. For many years to come he hoped that Mr. Worthington, who, he was sure, would prove so able a successor, would be able to consult his predecessor in times of difficulty such as were sure to arise in the conduct of every institution. The motion was seconded by Mr. Jeremiah Head, who said that it had been his lot to become President at a crisis in the history of the Institution, the tiding over of which was one great turning point in its career. He was the first president who served after the appointment of Mr. Bache as secretary. There was, unfortunately, a great deal of friction at the time, and if there had been a secretary of less good feeling and of less common sense the results might have been disastrous. The position was so strained at one time that Mr. Head had almost despaired of grappling with it, and had thought of resigning his post. It was then that the loyal support accorded to him by the secretary was most felt, and, happily, by the good offices of their friends and by the exercise of self-restrain and sound common sense, they had passed through the crisis successfully. He had much pleasure in seconding the resolution. The President next invited any member from the body of the hall to speak on the motion. In reply, Mr. Bernard Dawson, Mr. Hawksley, and Mr. Oughterson added their recognitions to the valuable services rendered by Mr. Bache during his long career of 43 years as a servant of the Institution. The motion was then carried with acclamation. Mr. Bache thanked the members for the kind way in which they had passed this vote. The incident was one of a series of kindnesses such as he had constantly received from the members of the Institution. The work of his lifetime had been a great pleasure to him, and he would say now, that if he had to start in life again and could select his career, he would choose no other position than the one he had filled. He could not answer all the kind things that had been said of him by Sir Douglas Galton and Mr. Head in proposing and seconding the motion, nor to the no less gratifying remarks of Mr. Dawson, Mr. Hawksley, and Mr. Oughterson. He would, however, make one reference to what Mr. Head had said about the trying time they had passed through when that gentleman was president of the Institute. Mr. Head had attributed too much to him; and, indeed, it was the sterling character of the president that had carried the Institution through that difficult and trying period. He cordially thanked the meeting for the way in which the vote had been carried, and would be pleased to assist the Institution to the fullest extent of his ability, should his advice or assistance be required by Mr. Worthington, who, he felt sure, would so ably fill the position to which he had been appointed.

Old News.—Our French contemporary, *L'Electricien*, informs its readers that a Russian engineer, whose name is not very formidable—no worse, at least, than Romanow—has invented a new form of electric suspension railway. Moreover, he has devised three types of it—one for mails and parcels, a second for goods traffic of medium weight, and a third for heavier goods or for passengers. Figures as to cost of construction, working expenses, &c., are also given, but in a form which cannot be understood. However, they do not affect this remarkable discovery (!) of a "telpher" system; which is, apparently, exactly what could be seen at work in this country 10 or 15 years ago.

X Rays in Medical Work.—The statement that at a Liverpool hospital X rays were utilised in no less than 57 cases during the year 1897, is followed up by the treasurer of the St. Thomas's Hospital, Albert Embankment, who says, in a letter to the *Times*, that at St. Thomas's as many as 416 patients passed through the X rays department during the year. So great is the pressure of work, that an assistant to the officer in charge is about to be appointed.

To Battery Makers and Users.—An interesting offer now being made by an American house for the purpose of popularising the Willard storage battery is worthy of attention from battery makers in this country. The firm requests anyone interested in storage batteries for whatever purpose, and especially for large power or lighting plants, to investigate the mechanical and electrical construction of the Willard cell. Inquiry is invited and scientific tests courted, and the company undertakes to supply anyone with the means by which he may investigate for himself the merits of the battery, and for the purpose of such test and comparision a single cell of any size is offered at half the net price. An investigation of cells which have been in use from two to five years is invited. There is no better recommendation for apparatus than to place it before the public for free and full investigation, and our American friends appear to appreciate the truth of this in the present instance.

W. T. Glover & Co., Limited.—Under our "New Companies" this week will be found a notice of the registration of this company, with a capital of £200,000, to take over the business of the well-known cable and wire manufacturers, Messrs. W. T. Glover & Co.

Electricity Meters.—A course of five lectures on "Electricity Meters" is to be given at the Finsbury Technical College, by Mr. Louis J. Steel, A.I.E.E., commencing March 3rd. See our "Official Notices."

Personal.—We notice in the *Bulletin Hebdomadaire of Posts, Telegraphs, and Telephones*, that it is probable that M. Raymond, the actual administrator of telegraphs in France, will retire shortly from the public service, and will be succeeded by M. Wünschendorff, who is well known to the English telegraph world. M. Wünschendorff at present is one of the inspectors general of French telegraphs. M. Raymond will be a difficult man to follow on account of his knowledge, industry, and urbanity.

NEW COMPANIES REGISTERED.

International Engine Patents Development Company, Limited (56,144).—Registered February 17th with capital £3,750 in 1s. shares, to acquire the assets and liabilities of New and Mayne, Limited, to adopt an agreement with New and Mayne, Limited, and D. F. Basden, its liquidator, and to carry on the business of mechanical, electrical, and general engineers, engine builders, and manufacturers of oil, steam, or electrical motors. The subscribers (with one share each) are:—O. Lloyd, 38, Montpelier Road, Brecknock Road, N.W., gentleman; J. W. Baldwin, 39, Northway Road, Loughboro' Junction, S.W., clerk; J. P. Bennett, 274, Ivydale Road, Nunhead, S.E., clerk; A. M. Mallett, 47, Bawdale Road, East Dulwich, S.E., clerk; S. F. Patmore, 8, Alvington Crescent, Dalston, clerk; A. Robinson, 8, Stone Buildings, Lincoln's Inn, solicitor; J. Shinley, 13, Model Buildings, Gray's Inn Road, W.C., clerk. The number of directors is not to be less than three nor more than five. The first are R. Hunt, W. Shrimpton, and A. G. New; qualification, 500 shares; remuneration, £300 per annum divisible. Registered office, 33, St. Swithin's Lane, E.C.

Gas and Electric Light Consumers' Protection Association, Limited (56,088).—Registered February 14th with capital £1,000 in £1 shares, to establish and carry on a system of periodically inspecting the registering indexes of gas and electric light meters. The subscribers (with one share each) are:—W. H. Robbins, 8, Linacre Road, Willesden Green, journalist; J. Cristol, 7, Richmond Road, Bayswater, financier; F. Thomas, Roeborough Park, Harrow, journalist; W. C. Daniels, 39, Chardmore Road, Stoke Newington, merchant; D. Davies, 50, Brondesbury Road, Kilburn, accountant; J. Cottrell, 83, Balmoral Road, Willesden Green, editor; F. C. Evans, 52, Queen Victoria Street, E.C., solicitor. Registered without articles of association by F. E. Evans, 52, Queen Victoria Street, E.C.

W. T. Glover & Co., Limited (56,124).—Registered February 16th with capital of £200,000 in £1 shares (100,000 £5 per cent. cumulative preference), to acquire the business carried on by H. Edmunds and G. B. Samuelson, at Springfield Works, Salford, Lancashire, as W. T. Glover & Co., to adopt a certain agreement, and to carry on the business of manufacturers of cables and lines for electrical purposes, electrical engineers, and contractors, manufacturers of electrical apparatus, and suppliers of electricity. The subscribers (with one share each) are:—H. Edmunds, 71, Upper Tulse Hill, S.W., electrical engineer; G. B. Samuelson, 7, Cadogan Gardens, S.W., electrical engineer; W. P. J. Fawcus, Derwent Bank, Keswick, engineer; J. Morton, 132, Waterloo Road, Manchester, manager; J. W. Moore, 28, Devonshire Street, Higher Broughton, Manchester, accountant; R. Taylor, 1, Weaste Road, Weaste, Manchester, cable maker; S. Hartford, 17, Woodland Avenue, Higher Broughton, traveller. The number of directors is not to be less than three nor more than five; the first are:—H. Edmunds, G. B. Samuelson, W. P. J. Fawcus, and H. P. Holt. Qualification, £2,000; remuneration as fixed by the company. Registered by Rowcliffes, Rawle and Co., 1, Bedford Row, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Salisbury Electric Light and Supply Company, Limited (41,414).—This company's annual return was filed on January 8th, when 1,307 shares were taken up out of a capital of £20,000, in £1 shares. £1,013 15s. has been paid, and £293 5s. is in arrears.

Railways' Electric Supply Syndicate, Limited (52,812).—This company's statutory return was filed on November 13th, when 7,000 shares were taken up, and issued as paid, out of a capital of £10,000 in £1 shares.

Silicon Electric Lamp Syndicate, Limited (47,238).—This company will not be proceeded with, as the patent for the acquisition of which the undertaking was formed have been otherwise disposed of, and the name of the company will be struck off the register.

Rand Central Electric Works, Limited (43,712).—This company's annual return was filed on January 7th, when the capital of £300,000 in £1 shares was taken up in full; 25,000 shares are considered as paid, and £275,000 has been received.

Single Wire Multiple Telephone Signal Company, Limited (16,857).—This company's annual return was filed on December 24th, when 374 shares were taken up and paid for in full out of a capital of £5,000 in £10 shares.

Smithfield Markets Electric Supply Company, Limited (53,354).—This company's statutory return, made up to November 29th, was filed on December 11th, 1897, when 73 shares were taken up out of a capital of £100,000 in £5 shares. £1 per share has been called, and £7 paid.

Taylor & Tucker Art Metal Company, Limited (28,892).—This company's annual return was filed on January 17th, when 4,400 shares were taken up out of a capital of £5,000, in £1 shares, and paid for in full.

Telescriptor Syndicate, Limited (47,635).—This company's annual return was filed on January 14th, when 39,507 shares were taken up out of a capital of £40,000, in £1 shares; 35,000 are considered as paid, and £4,507 has been received.

Sussmann Electric Miners' Lamp Company, Limited. (47,821).—This company's annual return was filed on November 30th, 1897. The capital is £80,000 in £1 shares (1,500 deferred, 39,250 preference, and 39,250 ordinary). 1,500 deferred, 27,073 preference, and 28,488 ordinary shares have been taken up. 1,500 deferred, 17,950 preference, and 17,943 ordinary shares are considered as paid. £1 per share has been called on the others, and £19,247 has been paid, leaving £421 in arrears. £191 has been paid on 376 forfeited shares.

Thompson, Ritchie & Co., Limited (35,835).—This company's annual return was filed on January 14th. The capital is £5,000 in £10 shares (200 preference). All the preference and 140 ordinary have been taken up, and 100 preference and 70 ordinary shares are considered as paid; £10 per share has been called on the rest, and £1,700 has been received.

Townsend, Tamplin & Makovski, Limited (53,914).—This company's statutory return was filed on January 6th. The capital is £20,000 in £10 shares (1,000 "A" and 1,000 "B"). 350 "A" and 401 "B" shares have been taken up, and 401 of the latter are considered as paid. £10 per share has been called on the rest, and £3,650 has been received.

Automatic Electric Railway Signal Company, Limited (37,636)—This company's annual return was filed on December 23rd, when 5,940 shares were taken up out of a capital of £10,000 in £1 shares; 4,300 shares are considered as paid, and £1 per share has been called on the others. £1,647 10s. has been received, including £7 10s. paid on 15 forfeited shares.

African Trans-Continental Telegraph Company, Limited (37,855).—This company's annual return was filed on January 4th, when the capital of £140,000 in £1 shares was fully subscribed. £116,450 has been paid, and £23,550 is in arrears.

Amazon Telegraph Company, Limited (44,532).—This company's annual return was filed on January 20th, when the capital of £250,000 in £10 shares was taken up, and paid for in full.

Electrical Copper Company, Limited (48,068).—This company's return was filed on January 18th, when the whole capital of £500,000 in £1 shares (150,000 preference) was taken up. The ordinary shares are considered as paid, and £1 per share has been called on the others. £148,266 10s. has been paid, and £1,733 10s. is in arrears.

CITY NOTES.

National Telephone Company.

The twenty-first ordinary general meeting of the National Telephone Company, Limited, was held on Thursday, last week, at Cannon Street Hotel, Mr. James Staats Forbes presiding.

In moving the adoption of the report, the Chairman said that knowing as they did the very great difficulties by which they were surrounded in carrying out the telephone business, they felt that the figures were exceedingly satisfactory, and they trusted that those present and those absent who had studied them as either affecting the past half-year or the past year, and who carried their knowledge back to former years, would be as satisfied as the board were with the progress the concern was making. They would observe that the growth of the business in the half-year had exceeded by £67,600 the receipts of the corresponding half of 1896. The working expenses had increased reasonably in relation to the large increase of the receipts themselves, and the accounts showed that the net result for the half-year, after deducting the Post Office royalties amounting to £46,000, was an increase of £23,474. In respect of subscriptions already received for services to be rendered in the coming year—that was to say, the year they were now in—they had the large sum of £473,586 in hand, an increase of £58,872. The available balance, £156,435, would enable them to do certain things, namely, to pay a dividend at the rate of 6 per cent. per annum, less income-tax, on the first and second preference shares, 5 per cent. per annum, less income-tax, on the third preference shares, and 6 per cent. per annum, free of income-tax, on the ordinary shares. That was really the long and short of the whole business; that was the outcrop of the working for the half-year. They would see by paragraph No. 6 that they proposed to transfer £40,000 to the reserve fund, and to carry the balance of £10,034 forward. That £40,000 that they carried to the reserve was £5,000 more that half-year than they had been in the habit of carrying to that fund for some time past. They next came to the capital expenditure—a very serious matter, but not unduly serious, seeing the progress of the business. They had expended the sum of £267,375 on capital accounts, which was a pretty good lump for one half-year; but it was only, after all, the embodiment of a growing business. In the half-year they had erected 5,633 additional exchange and private lines, and besides that there had been considerable expenditure in what really came to a transformation of the system from overhead to underground wires. The overhead system was attended with enormous difficulties, which rather increased. They imposed upon the company certain risks from time to time which not only caused a great deal of liability, but a great deal that was harassing in working the undertaking. The underground system was free from those contingencies. It was costly, of course, at the beginning; but as it secured greater efficiency in the conduct of the service, and at the same time safeguarded the company against serious risks, such as damage to the property from snowstorms, and dislocation of the service, they had come to the conclusion that the sooner they could substitute the one system for the other, the better it would be for the public and for the company. They had no powers over the streets, and had been confronted with great difficulties in making the change; but, happily, the difficulties experienced in that direction originally, had to a great extent been overcome, owing to patience, great diligence, and a great deal of interest, which the directors in various places individually exercised, together with the energy of the general manager, engineers and officials, and some of the more important centres had been enlightened enough to listen to arguments, and to enable them, upon something like reasonable terms, to carry out those transformations in those great centres. The result was that the moment these works were finished, there was a very perceptible improvement in the service, and an immediate decrease of the actual ground for complaint. They had to pay the great Corporation at Manchester the compliment of admitting that they were the first to realise that their duty was not to the company, but to the public, and several other places had followed suit. There were now many places where they were suffering greatly from the want of those facilities. London was one of them, but they were not without hope that London would follow the lead of Manchester, and also other great towns, in view of the great and growing importance of this service, and that they would grant reasonable facilities, without which it could never be made perfect. Between December 31st, 1896, and December 31st, 1897, there had been an increase of £113,800. They had paid the Post Office in royalties £89,238, being an increase of about £10,000 over the corresponding year, the net income had increased by £103,800, and the working expenses had increased by £74,900, which was rather a larger proportion of the gross income than was quite agreeable, although if challenged they should be able to defend it. The net result for the year showed an increase of £28,929. One was constantly being told how bad the service was, how costly it was, how extravagant the whole foundation was, and how much better it could be done by other people, and they justified the statement by certain figures. Either they must be living in perfect illusions, and must be absolutely densely ignorant of what they had to do, or else the other gentlemen outside must be somewhat ill-informed. He was afraid they were ill-informed. The popular theory was, that in London they could get a magnificent telephone service for about £20, and in the country for £5 or £6. That was not their experience, and they had had now a good deal of experience in the working of the business. In the year they had increased their subscribers' wires in London by 2,671, and, after all, wire was a factor. In all other centres of the United Kingdom the increase had been 9,110. That made the total increase in the year of 11,781 exchange wires, and brought the total, on December 31st last, up to the respectable number of 17,371 wires in London, and of 88,817 in all the other places, or a total of 106,188. That seemed a satisfactory progress. It was 18 per cent. in London and 11·43 per cent. in other places, or 12·48 upon the mean. The 1,219 wires in London cost, in actual cash, £53 12s. 8d. apiece to erect them, and the 4,414 in the country £45 16s. each, and that money had all to be found and buried in the earth, or put into the air, before they got a sixpence of return upon it. Now what became of those fallacies they had had drummed into them by a great many people—adventurous persons—and, what was more singular, by reputable organs which directed the public intelligence? Those figures could not be controverted, but they were inconvenient for certain people. Now, as to the awful rapacity of the company in regard to its charges: the average subscription in London for the whole year was £14 10s. 6d., and in the country £8 10s. 10d. That did not seem to be such a very extravagant charge, in any case, nor was the disproportion in London so great as they made it out to be, when they considered that London cost £53 12s. 8d. each wire, and more, to work, as against the cost in the country of £45 15s. The fact was, they wanted four or five years' subscriptions in hand to pay the first actual cost before a single telephonic message could be sent. The Post Office royalties came to no less than £89,000 of hard-earned sovereigns. What would be the effect if the Chancellor of the Exchequer could be persuaded to forego the royalties? Well, it would have the effect of taking £1 12s. 10d. off the London subscription, and thereby reduce it to a shade over £12, and it would take 18s. 2d. off the subscriptions in all other places. All that was conveniently ignored, and they were told that they should go to Stockholm or Norway, or some remote parts of the world for parallels. Circumstances had arisen which had seriously affected the comparison for the whole year, because in the year ended December, 1896, they had some portion of the trunk revenue, whereas that trunk revenue had entirely disappeared in the year ended December 31st last. They had, however, made up the loss sustained, which was a considerable figure. He did not know whether the substitution of the dual trunk system for their old one had improved the general convenience. In some places it had, but in other places they heard complaints that it was not quite so good as it used to be when the company was the sole worker of it. Of course, there was now a multiplication of delicate operations, anyone of which might fail and cause inconvenience or delay.

Lord Harris seconded the motion, which, after some remarks by Mr. Hastie, was agreed to.

The Kensington and Knightsbridge Electric Lighting Company, Limited.

The directors' report states that during the year the number of houses and shops connected with the system has increased from 1,325 on December 31st, 1896, to 1,620 on December 31st, 1897; while the number of lamps calculated on the usual basis of 8 candle-power has increased from 119,955 to 137,953. Additional capital required by the company during the year has been raised by the issue of £1,160 4 per cent. debenture stock, producing £1,240 and 2,000 second preference shares, offered to the shareholders at a minimum price of £6 per £5 share, were subscribed for, producing £12,219 12s. 6d. The directors have strengthened the renewal account by transferring to it £8,061 7s. 1d., making the total amount placed to that account £20,497 13s. 10d. After providing for the above amount, and paying the dividends on the 6 per cent. first preference shares to June 30th, 1897, on the 5 per cent. second preference shares to September 30th, 1897, and an interim dividend at the rate of 8 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1897 is £7,263 11s. Of the above sum, £1,450 has been appropriated to the payment of the first preference dividend to the end of the year, and £300 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date, leaving £5,513 11s., out of which it is proposed to pay a further dividend on the ordinary shares, at the rate of 12 per cent. per annum for the past half-year, making, with the interim dividend paid to June 30th, 10 per cent. for the year. This will leave a balance of £1,163 11s.

Bristol Tramways Company.

The half-yearly meeting of this company was held last week, the chairman (Mr. W. Butler) presiding.

The Chairman, in moving the adoption of the report and the declaration of a dividend at the rate of 6 per cent., said: Our receipts from the tramways' department show an increase of £9,494; this is, of course, largely made up of receipts from additional lines opened during the half-year, though by no means an inconsiderable portion of it is contributed from the horse lines, on which in consequence of better weather and increased service we have received more money. On the expenses side we can hardly give any minute comparison, as the amount of work done during the half-year so far exceeded that of the corresponding period. Under the heading of "horseing and traffic expenses" you will observe that the one item showing a large increase of nearly £3,000 is "wages of staff," which now amounts for the half-year to over £20,000. With regard to the items under the heading of "general expenses," these too have increased somewhat, consequent upon the additional business: the same remark applies to "renewals and repairs." We shall find that the repairs and maintenance of our tramway permanent way and rolling stock will cost very much more now that we have a large proportion of our system

worked by mechanical power. The balance of net revenue is £16,859, against £12,378 in the corresponding half, being an increase roundly of £4,500, but this is as it should be, seeing that our total capital expenditure is £100,000 more than it was at this time last year. We have now had between two and three years' experience in the working of electric lines, and to-day, out of a total route length of 20 miles, no less than 8½ miles are worked by us as electric lines, leaving 11½ miles of horse lines, so that we have got practical acquaintance in not only the receipts, but the expenditure side of the account. It will be seen from our balance-sheet that, notwithstanding this large proportion of electric lines, we are no more than holding our own in the way of dividend-earning capacity. Many who have been shareholders for years past know that the normal working expenses were about 80 per cent. Since the advent of electric traction on nearly half our system we have managed to reduce the average to 75 per cent. We are generally credited throughout the country—at least in tramway circles—with being able to work a tramway as economically as most people, but I may tell you that our experience of electric traction, after 2½ years, goes to show that our working expenses in that department cannot be reduced below 60 per cent.

The chairman then proceeded to criticise the attitude taken up by the Electricity Committee of the Corporation, and eventually the report was adopted.

G. R. Blot & Co., Limited.

A statutory meeting of this company was held at Cannon Street Hotel last week, Mr. Thomas Parker in the chair.

The Chairman said the future of the company was well secured owing to the fact that they had orders in hand and in view, and a very effective staff to carry out the requirements of the company. The capital of the company had been largely subscribed by English and French shareholders, and there were amongst both some very influential people. The French company, La Compagnie des Accumulateurs Electriques Blot, had been very successful, and has just received an order from the "Secteur" of the Champs Elysées, for a battery of 10,000 ampere-hours, discharging at the rate of 2,000 amperes per hour, one of the largest batteries in the world (if not the largest). Those who knew something of accumulators will understand the magnitude of this one, and he questioned if there was so large a one at present built. The company had 15 tons of plates to handle per week, so that we had every reason to hope that they will do quite as much at their factory at Wednesfield. The directors were proceeding as quickly as possible with the erection and fitting out of our new works near Wolverhampton, and in a few weeks would be able to commence delivery of accumulators on a large scale. The new company had everything in its favour: works admirably situated, with every facility for cheap transport by canal, railway, and the like. The freights being so reduced and rent so cheap, it was more than probable that handsome dividends would soon be paid. Situated as their works were right in the very heart of the electrical world, there was every reason to hope for a favourable result.

Elmore's French Patent Copper Depositing Company.

Mr. J. H. Duncan presided, on Wednesday, at Winchester House over a meeting of the first mortgage debenture holders of the above company to consider a proposal for the purchase of the founders' shares of the Société Française d'Electro Metallurgie, which constitute, practically, the main asset of the company. The sale of the shares would enable the sum of 6s. in the £ to be paid to the first mortgage debenture holders in discharge of their debt.

The Chairman said that for many months he had been trying to get an offer for the founders' shares of the French company which would be acceptable from their point of view. It had taken him many months to work from one figure to another until he got in the neighbourhood of £10,000, and then he thought it worth speaking to them about. They would remember that the company was taken out of liquidation at the time they sold to the French company under a scheme provided by the Court, which gave to them, as creditors, a first charge, represented by debentures for £35,000. Practically the one asset they then had in their hands was the bulk of 5,000 founders' shares, and certain rights upon the French company, viz., that after 10 per cent. had been distributed to the French shareholders, there should be a certain surplus coming over to them—he thought it was about 35 per cent. of the surplus profits to come to them. He did not know whether any of them was sanguine enough to think there would be any surplus coming. They took it simply as it was offered; they had had £60,000 from the company in other ways, and they had to take it. As a matter of fact, the Frenchmen had had to raise an immense amount of capital; they had had two increases of the capital, and were talking about a third, and had found that to work up a copper business, they had to pour a good deal of solid gold into it. A French company paying 10 per cent. was a *rara avis*, and it would be well to build a museum to put it in. He did not think that 10 per cent. would ever be put, and seeing a chance of getting something solid for the debenture holders, he thought it his duty to do so. They had a small amount of £600 in hand, and a few bonds, worth £1,000, and they had also £800 of shares in the company. Altogether, after paying certain liabilities and expenses, they would have left about £12,900. In the circular they suggested that 6s. should be paid to the debenture holders, but that would only take £10,300, and the sum they had would really pay 7s. 4½d. He would move that the 6s. be paid, but it was open for them to propose more.

Mr. Shurmer seconded the motion.

Mr. Holmes moved that 7s. 4d. be paid.

Mr. Saunders said he would like to move that an honorarium be given to the chairman, who had worked so hard for the debenture holders.

After discussion, it was agreed that 7s. 4d. in the £ be paid, but that 5 per cent. should be divided for the amount to be paid to the debenture holders *pro rata*, and presented to the chairman for his valuable services.

The India-Rubber and Gutta-Percha Company, Limited.

An ordinary general meeting of this company was held at Cannon Street Hotel on Wednesday, the Hon. Henry Marsham presiding.

The Chairman said that, in accordance with the wish expressed by shareholders, the debtor and credit side of the balance-sheet had been expanded; the contingent liabilities were also set forth. The turnover in the general business had been greater than that of any previous year, and the first six weeks of the present year showed a still further increase. On the other hand, very keen competition was met, and the desire to keep up the quality of goods made their task an arduous one. The rise in the price of rubber had had the effect of compelling the principal manufacturers to notify increase of prices in rubber goods. Their steamers had been employed during the year, and the works at Silvertown and Persan were being kept in a state of efficiency. After referring to the strike, which closed one department of their works, the chairman said that the normal condition of things had been restored. The great fire at Melbourne had destroyed their agency there, but the agent had informed them he had secured fresh offices, and their claims would be shortly made on the fire offices.

He concluded by moving the adoption of the report, Mr. Silver seconded.

General Trevor objected to the form of the auditor's certificate, and asked if it could not be altered. After some discussion the board promised to bring the recommendation of the shareholders to the auditors.

The resolution was then adopted, and the retiring director and auditor re-elected.

W. T. Henley's Telegraph Works Company, Limited.

The report of the directors states that of the £50,000 additional capital authorised by the extraordinary general meetings held in the spring, the directors limited the present issue to £25,000, reserving the remainder for future needs. The whole of the £25,000 was taken up by the shareholders or their nominees at 60 per cent. premium, enabling the reserve to be increased by £15,000. After negotiations with the local authorities (protracted for several years), Victoria Road, which intersected the works at North Woolwich from east to west, has been legally closed, and its site added to the company's property, which now lies within a ring fence. This great advantage was not obtained without the payment of a sum of £2,000 to the Woolwich Local Board of Health to be applied to some purpose of public utility. The annexed accounts show that during the past year a net profit has been made of £29,584 19s. 7d. After payment of debenture interest and income-tax, and making ample allowance for depreciation of buildings, plant, machinery, &c., there remains £23,936 5s. 7d., making with £14,294 6s. 7d. brought forward from last year a total of £38,230 12s. 2d. From this sum has to be deducted the £500 voted to the directors at the last general meeting, leaving £37,730 12s. 2d. available for distribution. The directors have transferred £7,500 to the reserve fund (in addition to the £15,000 premiums above mentioned), and they recommend the payment of the following dividends, viz.: on the preference shares 7 per cent., including the interim dividend of 3½ per cent. paid on September 1st last. On the ordinary shares at the rate of 12 per cent. per annum, including the interim dividend of 3 per cent. also paid on September 1st last. These payments will together amount to £22,941 0s. 7d., leaving £14,789 11s. 7d. to be carried forward.

Manchester Carriage and Tramways Company.

A special general meeting of this company was held in Manchester last week for the purpose of considering a Bill proposed to be introduced into Parliament in the present session to enable the company to work their tramways by mechanical power, and for other purposes.

Sir J. J. Harwood said that the common sense of the Bill was that outside Manchester and Salford there were a number of local authorities interested in some way or the other in tramways. If they were to determine that their tramways should be worked by electricity, it would be necessary for someone to find the electric current. The authorities would probably not provide it themselves. If they did, he dared say it would be all right for those who were intending to work the tramways. The Manchester Tramways Company had a very large interest in tramways outside the city and outside the borough of Salford, and if it should be found necessary to put down appliances and erect buildings for generating electricity, this Bill would enable them to go to the outside authorities and say that if they did not intend to produce the power for themselves, the company had power to produce it for them, and they could enter into a mutual arrangement with each other. If the authorities, on the other hand, decided to create the power for themselves, the company might try to arrange to use it.

The Bill was approved by the meeting.

The Notting Hill Electric Lighting Company, Limited.

The directors' report states that the expenditure on capital account at the date of the last balance-sheet stood at £99,104 17s. 6d., and during the past year a further sum of £14,079 7s. 10d. has been expended, chiefly accounted for by £11,769 13s. 11d. for mains. The total capital expenditure is, therefore, £113,184 5s. 4d., which is £3,184 5s. 4d. in excess of the capital issued. The balance due at the beginning of 1897 on the preference shares, £3,160, was called up and duly paid during the year, thus making the whole share capital of £100,000 fully paid up.

As announced in the report of 1896, the sum of £10,000 was raised by the issue of 4 per cent. first mortgage debentures maturing in 1931, and redeemable in 1907 at the option of the company by paying the debenture-holder a bonus of 5 per cent. These debentures were issued at the price of 106 per cent., and the applications were considerably in excess of the amount required. In accordance with the debenture trust deed, the amount of these first mortgage debentures is limited to 50 per cent. of the share capital actually issued and paid up. At present, therefore, there are £40,000 of debentures available for additional expenditure. The capital expenditure during the current year is estimated at £7,000, for which further debentures will be issued.

The following table shows the progress of the company:—

				£	s.	d.
1891	Lamps	6,056	Loss	554	18	6
1892	,,	9,438	Profit	112	6	1
1893	,,	12,153	,,	1,481	7	1
1894	,,	15,669	,,	2,101	17	8
1895	,,	20,307	,,	3,227	14	10
1896	,,	25,716	,,	4,736	9	8
1897	,,	33,000	,,	6,854	1	2

The directors have set aside £1,000 for the depreciation and reserve fund, and have paid a dividend of 6 per cent. on the ordinary preference shares for the year ending December 31st, 1897, amounting to £1,767 14s. 4d. After payment of interest and leasehold redemption a balance is left of £3,884 18s. 1d., out of which the directors recommend that a dividend be declared on the ordinary shares at the rate of 6 per cent., less income-tax, which will absorb £3,871 4s. The sum of £401 16s. 2d., being the premiums received on the issue of £10,000 first mortgage debentures, after deduction of the legal and other expenses, has been written off the preliminary expenses account.

The company has hitherto supplied current at the standard pressure of 100 volts, the price charged being 8d. per unit. In March last the directors decided to supply current at a pressure of 200 volts, at a charge of 6d. per unit, less the usual rebates for long hours. It is not proposed to disturb existing contracts on the old basis, but every facility is given to those desiring to change. A contract has been entered into with the National Electric Free Wiring Company, Limited, which will enable intending consumers to obtain current without initial outlay for wiring or fittings. This only came into force at the latter end of the year, and already 17 houses have been connected on these terms. Very considerable inconvenience has been caused to the engineering staff by the non-delivery of the new and additional machinery ordered in the early part of last year, owing to the labour troubles in the engineering trade. Fortunately the company were able to meet all demands on them without any accident or break-down. Great credit is due to the manager and the staff generally for their care and energy during this very anxious time, which happily is now passed.

Blackpool and Fleetwood Tramroad Company.

The half-yearly meeting of this company was held in Manchester last week, Mr. G. R chardson, deputy-chairman, presiding.

The Chairman said that the balance-sheet showed the company had expended £82,000 on capital account up to January 17th, and they had got a small amount back by the sale of materials. He hoped that at the next annual meeting they would be able to present a satisfactory revenue account from the receipts they would expect to get on the opening of the line. The progress of the works had been satisfactory so far, and they had every expectation that the line would be opened for a great portion of the summer traffic. They had got all the rails down from the Glynn into Fleetwood. The works that were not progressing so quickly were those which the Corporation had in hand. The weather had been very bad, and they had had to contend with it. When the line was finished they would have a tramroad at a very low cost. It was stated that by June the line would probably be open right from Talbot Road Station, Blackpool, to Fleetwood. The meeting authorised the issue of £40,000 debentures.

Telegraph Construction and Maintenance Company.

The report of the directors states that the accounts for the year show a net profit of £61,131, after charging the interest on the debentures. To this sum must be added £39,940 brought forward from last year, making a total of £101,071. From this amount is deducted the interim dividend of 5 per cent., paid July 20th, 1897, amounting to £22,410, leaving £78,661 to be dealt with. Of this sum the directors propose to distribute a dividend of £1 4s. per share, absorbing £44,820, being at the rate of 10 per cent., and making, with the amount already paid, a total dividend for the year of £1 16s. per share, or 15 per cent., free of income-tax, leaving £33,841 to be carried forward to the next account.

Scarborough Electric Light Company.

The sixth annual general meeting of this company was held last week at Scarborough. Mr. George Alderson-Smith, J.P., presided, and in moving the adopting of the report and balance-sheet, said the company during the past year had spent more money than previously, but it had had an effect which was satisfactory. In Scarborough they were handicapped by the price of coal. In Leeds £17,000 of current was produced with a coal bill of £875; in Scarborough the current amounted to £5,300, and the fuel to £1,138. Perhaps a small destructor might be placed on the premises of the company, and as it was only a matter of time before the Corporation purchased the undertaking, it would be doing something towards the future.

Mr. J. B. Simpson seconded, and the report was adopted.

A dividend of 5 per cent. was declared.

Cape Electric Tramways Company.

The statutory meeting of this company was held on Wednesday at Winchester House, Colonel Sir Charles Euan Smith in the chair.

The Chairman, in speaking of the history of the company, said it was formed for the purpose of taking over, as going concerns, the tramway companies then existing at Cape Town and at Port Elizabeth. The company took over these tramways in good working order, and has since made many extensions and improvements, and the whole system is now worked by electric power. Since July 1st, 1897, until the completion of the six months ended December, 1897, the Cape Tramways Company has carried 3,300,000 passengers, which aggregates about 30 times the total population of Cape Town and its suburbs. For July last the traffic receipts showed the gross total of £5,587, but since then the earnings have steadily increased, and the total traffic receipts for December last amounted to £8,815, and January's total shows a further increase, the receipts amounting to £9,400. After giving further details of the system, the chairman said, for the six months ended December, 1897, 869,559 passengers have been carried on the Port Elizabeth system, and they have paid £11,984 in fares. Their receipts for last July—the first month of their operations—were £1,397, and the total receipts for December amounted to £2,734. Having regard to the earnings of the tramways, the directors were able to declare an interim dividend of 2½ per cent. on the last six months' working, notice of payment of which will be given in the usual course.

After further remarks the meeting terminated.

County of London and Brush Provincial Electric Lighting Company.—The directors have decided to recommend payment of a dividend on the preference shares for the six months ended December 31st last, at the rate of 6 per cent. per annum, less income-tax, carrying forward £10,000 to next account. The transfer books and register of members will be closed from 1st to 14th prox., both days inclusive, preparatory to the payment of the preference dividend. The ordinary general meeting will be held on 14th prox., at 2 p.m., at Winchester House.

Buenos Ayres and Belgrano Tramways Company.—The transfer books will be closed on and after to-morrow for repayment at par with accrued interest on 1st prox., of the stock held by proprietors who have not accepted the option of conversion into the 5 per cent. debenture stock of the Buenos Ayres and Belgrano Electric Tramways Company, Limited.

Stock Exchange Settlements.—The Stock Exchange Committee has (1) appointed Wednesday, March 2nd, a special settling day in Electric Construction Company, Limited.—£111,100 4 per cent. perpetual first mortgage debenture stock, and has ordered same to be officially quoted.

Telegraph Construction and Maintenance Company.—The transfer books will be closed from the 21st inst. to the 1st. prox., inclusive, preparatory to the payment of dividend.

British Electric Traction Company.—The letters of allotment and regret in the issue of 10,000 6 per cent. cumulative preference shares were posted last week.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending February 18th, 1898, were £2,399 2s. 8d.; corresponding period, 1897, £2,088 7s. 11d.; increase, £310 14s. 9d.

The City and South London Railway Company.—The receipts for the week ending February 20th, 1898, were £1,051; week ending February 21st, 1897, £1,044; increase, £7; total receipts for half-year, 1898, £8,565; corresponding period, 1897, £8,717; decrease, £152.

The Dover Corporation Electric Tramways.—The receipts for the week ending, February 19th, 1898, £104 13s. 9d.; total receipts, February 19th, 1898, £747 17s. 11d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, February 18th, 1898, were £385 7s.; corresponding week last year, £484 1s. 8d.; decrease, £98 14s. 8d.; passengers carried, 65,874; corresponding week last year, 73,303; aggregate to date, £2,863 12s. 8d.; aggregate to date last year, £2,947 10s. 8d.; decrease to date, £83 18s.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending February 20th, 1898, amounted to £1,320; corresponding week last year, £1,330.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending February 18th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,819.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Feb. 16th.	Closing Quotation, Feb. 23rd.	Business done during week ended Feb. 23rd, 1898. Highest.	Lowest.
137,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 - 104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares	10	...	...	...	6 — 7	6 — 7	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	60 — 62 xd	59 — 61	61½	58½
3,038,020£	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	110 —111 xd	107½ 108½	110⅝	107
3,038,020£	Do. do. Defd.	Stock	...	...	...	12½— 13	11⅝— 12½	12½	11½
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16⅝— 17½	16⅝ - 17½	17⅛	16⅝
75,000£	Do. do. 5 %, Debs., 2nd series, 1905	100	5 %	...	...	112 —116	112 - 116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	187 —192	187 —192	193	...
653,586£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 —108	106 —108	107½	106¾
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	⅞— ⅞	⅞— ⅞	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	7½— 8½	7½ - 8½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	17½— 18½	15½ — 16½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	10⅝	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	...	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10⅜— 11¼	10⅜ - 11¼	11 3/16	10 15/16
120,000	Direct West India Cable 4½% Reg. Deb.	100	...	...	...	98 —101	98 —101	99¾	99
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	18 — 18½	18 — 18½	18⅝	17⅞
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	19 — 20	19 — 20	19½	19
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 —103	100 —103	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	131 —134	131 —134	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7¾	...	18⅜— 19¼	18⅜ - 19¼	19⅛	18⅞
25,200£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,849, 3,976 to 4,326	100	5 %	5%	...	99 —103	99 - 103	...	...
100,500£	Do. do. Bearer, 1,850—3,975 and 4,327—6,400	100	5 %	5%	...	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4%	...	130 —133	130 —133	...	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	...	99 —103	99 —103	...	...
69,200£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4%	...	102 —105	102 —105	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	108 —111 %	108 —111%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	12 — 12½	12 — 12½	12 5/16	12¼
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	18 — 18½	17⅜ - 18½	18⅛	17 13/16
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	27½ — 28½	27½ — 28½	28¼	27⅞
160,000£	Do. do. do. 5 % Debs.	100	5 %	5%	...	101 —104	101 —104	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	108 —111	108 - 111	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000	5	4 %	...	...	2 — 2¼	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6⅞— 7⅛	6⅞— 7⅛	7 1/16	6 13/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	16 — 18	17	16½
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 16	15 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6 5/16	6⅛
130,766	Do. do. Nos. 119,235 to 250,000, £5 paid	5	...	...	5 %	6 — 6½	6 — 6½	6	...
329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —109	104 —109	105¾	105½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝— ¾	⅝— ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 - 145	139 —144	142	140
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	4¼	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	...	...	101 —106	101 —106	...	...
15,609	West African Teleg., Ltd., 7,561 to 23,169	10	4 %	nil	...	4¼— 4⅜	4¼ - 4⅜	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 - 106	103 —106	...	...
64,268	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	10½ - 11	10½ - 10⅝	10⅝	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	...	7¼— 8	7½ — 8	7⅝	...
33,129	Do. do. do. Def. Ord.	7½	1 %	...	...	3½ — 4	3½ — 3⅝	3½	...
382,230	Do. do. do. 4 % Deb. Stock Red.	Stock	...	...	...	105 —107	105 —107	106	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	1 %	...	⅛— ¼	⅛— ¼	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	8 — 8½	8 — 8¼	8½	8¼
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,600	100	5 %	5 %	...	105 —108	105 —108	...	...
163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100£	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	14 — 15	14 — 15	14½	...
20,000	Do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6¼xd	6 — 6½	6½	6⅛
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277	5	5 %	5 %	...	11⅜— 14½	11½— 12	12¼	11⅜
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	...	115 —117	115 —117	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001—80,000	10	5 %	7 %	10 %	28½ - 29½	28½ - 29½	29½	28½
10,000	Do. do. Prov. Certs.	5	...	...	10 %	27½— 28½	28 — 29	27¾	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½— 18½	17½ - 18½	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	131	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	*nil*	*nil*	*nil*	15⅜— 16½	15½— 16	15⅝	15⅜
20,000	Do. do. do. 6% Pref., 40,001—60,000	10	6 %	6 %	6 %	15⅜— 16½	15⅜— 16¼	16	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	10½— 11½	10½— 11½	11¼	11 1/16
10,000	Do. do. 7 % Cum. Pref.	5	...	...	...	11½ — 12	11½— 12	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	4 %	5 %	...	20 — 21	20 — 21	20 5/16	20½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10	...	...	...	19½— 20½	19½— 20½	20¼	...
220,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 —121	117 — 121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	18½ — 19½	19 — 20	19¾	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	10½%	14½%	18½ — 19½xd	18½— 19½	19½	19
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10⅜— 11 xd	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red.	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅞— 3⅛	2⅞— 3⅛	3⅛	3 1/16
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000	5	7 %	9 %	12 %	18 — 19	18 — 19	18⅝	18½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation Feb. 16th.	Closing Quotation, Feb. 23rd.	Business done during week ended Feb. 23rd, 1898. Highest	Lowest
30,000	British Electric Traction	10	...	...	...	17½ — 18	17¼ — 17⅜	17⅛	16¾
90,000	Brush Elect. Engng. Co., Ord., 1 to 90,000...	5	...	...	...	2 — 2¼	2 — 2¼	2 1/16	2
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2⅜ — 2⅜	2¼ — 2⅛	2 7/16	2¼
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	...	...	...	109 - 113	109 —113	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	02 —105	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	10½ — 11	10½ — 11	10⅞	10⅜
143,106	Do. do. do. £6 paid	10	...	...	...	6½ — 7	6⅝ — 7	6⅝	6½
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 2	1½ — 2	1⅞	1 11/16
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4½ — 5	4½ — 5	5	4 13/16
630,000£	City and South London Railway	Stock	1 8/16 %	1 9/16 %	1⅞ %	68 — 70 xd	66 68	68½	66
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	...	...	2¼ — 2⅜	2¼ — 2⅜	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2½ — 3 xd	2½ - 3	2 13/16	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5xd	4 — 5	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝ - 2⅞	2⅝ — 2⅞	2 13/16	2 11/16
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅛ — 3⅜	3⅛ — 3⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	...	...	...	1/16 — 3/16	1/16 — 3/16	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	3/16 — 5/16	3/16 — 5/16	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	...	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 ½	22½ - 23½	22½ - 23½	23½	23 1/16
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	19 — 20	19 — 20	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½ %	112 - 117	112 —117	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	22 — 23	22 — 23	22⅝	22⅝
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103 —107	103 —107	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2½%	2⅝%	3½	10 15/16 - 11 1/16	10 13/16 - 10 15/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½ — 16½	15½ — 16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	39 — 42	39 — 42	40½	39
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000	10	...	...	...	13⅜ — 14¼	13⅜ — 14¼	14¼	13¾

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%§ 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 11.

Electric Construction Corporation, 6 % Debentures, 105—107.

House-to-House Company, 4½% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16¾—17¼; 1st Preference Cumulative 6 %, £5 (fully paid), 8½—9. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4⅝—4⅞.

* T. Parker, Ltd., £10 (fully paid), 14½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

INSTITUTION OF ELECTRICAL ENGINEERS.

ON THE MANUFACTURE OF LAMPS AND OTHER APPARATUS FOR 200-VOLT CIRCUITS. By G. BINSWANGER BYNG, Member. (Paper to be read February 24th, 1897.)

In the progress of electrical industry, manufacturers have become accustomed to sudden demands arising from a discovery or a successful experiment, and I propose to deal with apparatus which manufacturers are called upon to make to meet the requirements of the latest innovation—*i.e.*, the distribution at a potential of 200 to 230 volts. Central station engineers have thus arranged their three-wire system, relying upon makers to successfully alter lamps and minor fittings incidental to such a change. Their expectations have been fulfilled in a measure only. The ultimate success of the high-pressure system will depend largely upon the verdict of the consumer, and he will give it in its favour only if his fittings, in points of efficiency, economy, safety, convenience, and appearance, approach the standard which he can obtain by means of the lower voltage system.

It is, therefore, of importance that the central station engineer should assist the manufacturer to arrive at such perfection. His instructions, so far, have hardly gone beyond the demand to supply him with fittings to conform in appearance to the 100-volt system. It is true each central station has issued rules, but they are of little help to the manufacturer, and their very disconformity shows that there is neither unanimity nor correlation of ideas between the engineers in charge.

What is wanted is to have a thorough interchange of opinion of engineers, contractors, and manufacturers. The latter would then know theoretically how far they may satisfactorily depart from the present practice, and thus save much time and money in adventitious experiments; and this also might tend to produce some degree of standardisation—much to be desired in the interest of all who have the success of the new system at heart.

With this object in view I bring this paper before you, and I think I can best serve the purpose by describing the chief appliances now upon the market, or under manufacture at my works, pointing out the existing deficiencies, and giving you my views upon the attainment, as far as possible, of higher perfection.

INCANDESCENT LAMPS.

Most important in connection with this subject is the incandescent lamp.

The lamp manufacturers have been compelled to supply 200-volt lamps at a given candle-power and efficiency, in the same size bulbs as are used for 100-volt lamps. With flashed carbon the manufacturers meet with the great practical difficulty of properly disposing their long, thin, 200-volt filament in the same space as their shorter and thicker 100-volt filament, and therefore most of them solve this problem by resorting to a filament of much higher specific resistance than would be given by the flashing operation.

Unflashed Filaments.—Such a lamp is ready to the maker's hand by simply taking his ordinary carbon filament as it exists before being flashed—that is to say, before it is reduced by a fresh layer of carbon being deposited on the surface of the original filament.

The higher specific resistance of an unflashed carbon enables one to easily get over the difficulty of size of bulb, as such a filament will give the necessary resistance by taking a shorter length. Such filaments have also a greater emissivity, owing to the darker and rougher nature of their surface than that of flashed filaments; consequently they require a less amount of surface per candle-power, and therefore the mass of an unflashed filament, at a given candle-power and efficiency, is less than that of the flashed filament.

The filaments of high-voltage lamps largely used to-day are therefore, in other words, faster converters of energy into heat and light than flashed filaments of the same candle-power and efficiency, although the watts supplied to each be the same.

On comparing the behaviour of such 200-volt lamps with that of 100-volt lamps, the roughest of tests shows that there is a far more rapid falling off of candle-power during life with the former than the latter. At the same time the efficiency of an unflashed lamp decreases in a given number of hours by a far greater percentage than is the case with the flashed lamp. Mr. Robertson has made a series of life and efficiency tests on high-voltage lamps. They show that in the average unflashed 200-volt 16-C.P. lamp the percentage loss of candle-power in 600 hours is about 42 per cent., and the average drop of efficiency is about 35 per cent.

These two quantities seem to cover the chief practical merits desirable in an incandescent electric lamp—*i.e.*, the lamp which has the best percentage retention of original candle-power during its life, together with the best average percentage retention (or increase) of original efficiency during its life.

These tests show that these most desirable points, which have

been worked on diligently for the last 13 years, have had to be thrown on one side in order to bring about the possibility of using the same sized bulb for a given candle-power at 200 volts as at 100 volts.

Tests of the behaviour of unflashed high-voltage lamps show that such lamps sometimes increase in candle-power during the first 100 hours or so. This also happens with badly carbonised or badly flashed 100-volt lamps (noted by Prof. Ayrton in some of his recent lamp tests), owing to the initial lowering of their resistance in consequence of their not having been properly carbonised in the first instance; and this is often accompanied by a great alteration in the character of the surface (emissivity) of the filament. The carbonising or baking progress is therefore still going on in the lamp, and the two above-mentioned changes coming together mask the fact that a great deterioration of the filament has taken place; but a period is quickly reached when this fact is no longer masked. This period is when there is no further decrease of resistance; but the surface deterioration still goes on, and thus soon brings about a large percentage fall of candle-power, and on the slightest increase of voltage there is now a tendency to increase resistance. These changes seem to be initially owing to the fact that the (unflashed) high specific resistance carbon is far more volatile than is the case with a good flashed carbon.

A microscopical examination of a flashed and unflashed filament, after each has been running 100 hours, shows that the surface of the flashed filament is still quite smooth and shiny, whereas the surface of the unflashed filament has become very dull, sooty, and often full of small pit-holes. These pit-holes and soot form a large increase of surface, which therefore increases the emissivity of the filament, and consequently lessens its candle-power, as the watts supplied keep the same.

The property of an unflashed filament becoming so rapidly less efficient (increasing in watts per candle-power) acts as a preservative, because the increased emissivity lowers the temperature. This lowering of temperature decreases both the tendency to volatilise, and also to further great change of resistance. This power of self-preservation leads to such a filament giving some satisfaction to the general public, for the latter is satisfied when it obtains a good average, or sometimes an excessively long-life lamp; but this is a very false economy, as it is only purchased by a very great falling off in actual efficiency.

Mr. Robertson's experience with carbon filaments seems to point to the fact that *it is impossible to obtain a carbon filament of high specific resistance without its being accompanied by at least the defect of greater volatility.* In other words, the lowest specific resistance carbon is the best, because it is less liable to evaporation, and therefore it gives the best retention of original candle-power and efficiency, and it is also mechanically stronger.

The specific resistance of many of the present types of 200-volt lamps is about 3,500 to 5,000 microhms per cubic centimetre, whereas it is easy to obtain flashed carbons whose specific resistance is as low as 2,400 microhms per centimetre; and even as low as 300 is possible, but not practicable.

Gases.—Another important consideration to bear in mind as to whether the high or low specific resistance carbon is the best, is that the high specific resistance filaments retain their occluded gases in a far more persistent degree than is the case with the low specific resistance flashed filaments.

It is probable that the occluded gases arising from the carbonisation of the filament are, by means of the flashing process, driven off to a large extent; and, in addition, the more dense and impervious nature of the flashed surface prevents the filament from absorbing the gases during its subsequent handling or treatment. This absorption is a property possessed by all carbon bodies in some proportion, varying with their density.

This greater power of unflashed carbon to absorb gases and to retain what it has absorbed, than is possessed by flashed carbon, leads in many instances to sudden deterioration of the vacuum in a finished lamp, accompanied by short-circuiting as soon as the pressure and the condition of the residual gases in the bulb has reached its most conductive point.

The consensus of opinion at the present day of the average types of high-voltage lamps undoubtedly points to the fact that a large percentage are expected to short-circuit as soon as they are put up, and I have heard several engineers say that they expect about one in twelve to go in this way.

From these causes, and others relating to the treatment of filament pointed out above, there seems to be no doubt that the average 200-volt lamps have a shorter life than 100-volt lamps. The above experiences have led Mr. Robertson to design all high-voltage lamps that are not restricted by size with well-flashed carbon filaments, and such lamps compare favourably with lower voltage lamps.

Horizontal Burning.—Another question which is very important in considering 200-volt lamps is that of horisontal burning, and contractors should take special notice of this. There is no doubt whatever that almost all the present-day 200-volt lamps are only suitable for burning in a vertical position. As soon as any other position is adopted defects become prominent. The long thin filament soon drops on to the bulb and cracks it. Also electrostatic attractions, owing to higher voltage, cannot be resisted by the long thin filament, and this is an additional cause of the filament approaching the bulb.

The effect of electrostatic attractions on long thin filaments is even noticeable with lamps burning in a vertical position. Such lamps have to be designed with the object of making their filaments more rigid, and to be thus able to withstand the effects of gravity and electrostatic attractions exerted by the charge on the bulb; and this is the chief point which makes high efficiency 200-volt lamps so difficult to produce. There is, therefore, a tendency, in trying to avoid the defects just mentioned, to make 200-volt lamps as low in efficiency as possible.

Leading-in Wires.—Another fault that exists with the bulk of the present forms of high-voltage lamps is that, owing to the same size bulb being retained, no greater separation can be given between the leading-in wires of the lamp. This is a special difficulty with high-voltage lamps which contain two filaments, as in this case the same size cap is used, and four wires are passed through the sealing point instead of two, and they are therefore more crowded together. This question of distance apart of leading-in wires is a vital one, both in the manufacture of the lamp and in its after use. In the case of unflashed carbons this becomes a still greater defect, owing to small distance combined with probably greater gaseous emanation.

The higher the voltage, the sooner are these defects made manifest. Even with 100-volt lamps there is, under certain conditions, a tendency for current to jump across from pole to pole, owing to the remanent gases in the bulb attaining a high state of conductivity. The greatest conductivity of the remanent gases which lead to sudden short circuiting appears to be when the pressure is about 0·01 mm. But, by reason of a continued discharge taking place in all lamps, there seems to be a tendency for the residual gaseous molecules to arrange themselves in a straight path between each pole. Through such a path discharge will take place even in a better vacua than 0·01 mm.

This leakage current (sometimes called the "Edison effect") which leads to short circuiting is very prominent during manufacture of high-voltage lamps, and to avoid it, greater care is required as the voltage increases.

If the size of a bulb for a high-voltage lamp is to be restricted to the present dimensions, there is no doubt that the best lamp would still be that which has a single filament, were it not that other vital questions step in.

Electrostatic effects also increase with the voltage, and several most promising patterns of lamps, from all other points of view, have had to be put on one side on this account.

As to the best forms of cap for high-voltage lamps, preference will naturally be given to those in which the poles can be kept furthest apart.

If a B.C. or E S. cap were on a larger scale, there is no doubt that considerable benefit would accrue. The simplest holder, with the least moving parts and for always making the best contact, is undoubtedly the Edison screw, which, in the cases of excessive vibration, can be made with a locking device.

The slightest want of insulation in the cap between the poles eventally leads to a large leakage current between them or the cap and one of the poles, and in many cases this is suddenly established to such a large degree as to result in the complete fusion of the lamp cap, and sometimes the holder. In such cases a non-metallic lamp cap seems to offer great advantages, and has, in my experience, removed complaints on this score.

Standard Voltage.—From a lamp maker's point of view, a fixed standard of voltage and efficiency would only lead to an increased cost in manufacture, and the present practice of varying efficiencies with voltages, running in the case of low-voltage lamps from 95 to 120, and in the case of high-voltage lamps from 200 to 230, tends to keep the lamp at a lower cost than if these efficiencies or limits of voltage were more restricted.

On the other hand, voltages which lie outside these limits are a source of great expense to the manufacturer. It would, therefore, tend to cheapen lamps if a standard of voltage were adopted which lay exclusively between the above or even smaller limits, but at varying efficiencies.

Combination Filaments.—In order to get over the difficulty of size of bulb, &c., many filaments (beyond the unflashed pure carbon derived from cellulose in some form) have been introduced which have a high specific resistance. This can only be obtained by using a less dense form of carbon than has hitherto been found most satisfactory in low-voltage lamps.

A form of high specific resistance filament that has been tried is where the carbon has been admixed with various oxides, borates, and silicates of the earths. In addition to mixtures, electrolytic and chemical deposits of these bodies on the surface of carbon have also been tried; but, although it is a simple matter to obtain baked carbons containing these bodies, either incorporated with the carbon or on the surface thereon, it is quite another matter to obtain a finished lamp containing these bodies in a form to be of any practicable use. The difficulties met with are apparent as soon as the lamp is incandesced while undergoing exhaustion.

If such lamps be incandesced to a temperature exceeding about 5 watts per candle-power, there is a gradual separation by evaporation of these bodies from the carbon, and their resulting deposition on the surface of the lamp bulb.

The temperature of incandescence of the filament, in order to obtain any advantage which might be derived from the "luminescence" of the rarer earths is apparently greater than 5 watts per candle-power; and as, as above stated, it has been found impossible to so evacuate a lamp as to leave any of the "luminescent" bodies incorporated with the filament at temperature higher than 5 watts per candle-power, the object sought for is consequently defeated.

From the above, it seems that, with our present knowledge, the best form of 200-volt lamp is that which has a well-flashed low specific resistance pure carbon filament in a large bulb, with a well-insulated moisture-proof cap allowing the poles to be placed at a reasonable distance apart. It should consist of a single filament, and be so disposed in the bulb that it can withstand the disturbing effects of gravity and electrostatic charges on the bulb.

I wish to mention here that my co-director, Mr. Robertson, has given me great assistance in the remarks I have made upon lamps.

Switches.

I come now to the matter of adapting switches, wall plugs, ceiling roses, lampholders, and minor fittings.

I do not apprehend any difficulty in changing existing types from the present standard of use to conform to the higher standard, yet maintaining the same appearance and size, and, when sufficiently in demand, approximately the same cost. The chief alteration will be in the increased break, and better insulation of the two poles. In smaller articles, such as combined switches and lampholders, the difficulty, if any, is more apparent. A discussion bearing upon the subjects involving the use and construction of double-pole switches, length of break, standardisation of terminals, position of fuses, the carrying capacity of contacts, &c., would be, to my mind, of great value.

(*To be continued.*)

TESTS OF THE SYNCHRONOGRAPH ON THE TELEGRAPH LINES OF THE BRITISH GOVERNMENT.*

By ALBERT CUSHING CREHORE and GEORGE OWEN SQUIER.

(*Concluded from page* 244.)

Under the latter condition the synchronograph and Wheatstone receiver sent 666 words per minute, corresponding to 266·4 complete waves of current per second. The coils of the receiver were joined in parallel, and no condensers were used. Voltage, 175. In this line, where the mechanical limit of the Wheatstone receiver is reached before the speed is limited by the total value of K R of the line, it is seen how the perfect regularity, equality and shape of the sine waves materially increased the speed of the Wheatstone receiver.

With the synchronograph and chemical receiver the alternator was run higher than before, until a rate was attained of 1,446 single impulses per second.

With the line earthed the Wheatstone transmitter and receiver sent 360 words per minute with a voltage of 100. The synchronograph and Wheatstone receiver sent 540 words per minute, voltage 200. The receiver coils were in parallel, and a condenser was shunted across the coils. No limit was obtained in this experiment.

The longest line as yet tested, of 1,097 miles, was then made up, from London to Aberdeen *viâ* York and Edinburgh, and return *viâ* Glasgow and Leeds. A portion of the line north of Edinburgh was iron wire upon the same poles, going and returning. With no earth the total K R was 65,304.

Wheatstone transmitter and receiver sent over this line 185 words per minute, voltage 100. Synchronograph and Wheatstone receiver sent over this line 540 words per minute, voltage 215. Synchronograph with chemical receiver sent at frequency of 723 or limit at which it was safe to run the alternator. This result was higher than expected from the approximate law indicated by the preceding trials, and a reason for this was sought. The line was broken at Aberdeen, and records were still received. It was then restored at Aberdeen and broken at Glasgow, when, as before, no record was obtained. The cause of this was thought to be the inductive effect of that portion of the line beyond Glasgow, where the iron wires going and returning were unavoidably upon the same poles.

With an earth connection the total K R was 261,215, and the Wheatstone transmitter and receiver sent over this line 46 words per minute, voltage 100.

The synchronograph and Wheatstone receiver sent over this line 135 words per minute, voltage 85, coils in series L = 3·46, condenser of 5·75 microfarads shunted across coils.

The Transmission of Intelligence in Great Britain.

One of the reasons for going to England was to become conversant with the method of conducting the telegraph and telephone business in conjunction with the general postal service in a country where these three departments are under the control of the Government.

In the prosecution of this, as in the experiments themselves, every facility was afforded by the Government officials.

It is recognised that to draw correct conclusions upon the general subject of the transmission of intelligence requires men of experience in dealing with such matters, who give the subject their attention for a considerable period. Some of the principal facts, however, seem to be so clearly defined in their relation to others that we feel warranted in making some observations thereon.

The telegraph revenue and expenditures have increased with approximate uniformity. In 1872 the revenue was about $18,200,000, and the expenditure about $14,500,000, while in 1896 the revenue was $69,700,000 and expenditure $70,500,000. These two items have nearly coincided during 25 years, showing that the telegraph business is conducted on the whole to meet the expenses only and leave no profit. In some years the expenses are greater than the revenue, and the account shows a deficit. This has been the case for the last five years, but it has been gradually decreasing for three years, and in 1896 was only $168,000.

The number of telegrams forwarded from telegraph offices in the United Kingdom in 1871 was 9,850,177, and in 1896 was 78,839,610. In 1896 the ratio of the number of letters to telegrams was 18·5.

The charge for transmitting ordinary telegrams is a half-penny, or one cent per word, including the address, independent of the distance. The minimum charge is 6d., or about 12½ cents. The telegraph is used to a much greater extent for transmitting news in England than in any other country; for instance, in 1896, 5,915,646 telegrams were transmitted at the press rates for newspapers, clubs, &c. The average weekly number of words contained in these telegrams was about 13,650,000. The average length of each telegram is therefore 120 words. The explanation of this is found in the reduced rate given to the press after 6 p.m., which is at present but 6d. per 100 words. This press matter is handled almost entirely by the Wheatstone automatic system, automatic telegraphy being more advanced than in any other country in the world. There are as many as 447 sets of Wheatstone instruments in use in Great Britain, and for press messages pneumatic perforators are used, and a number of duplicate strips are prepared at once, and thus the same press news may be sent out on eight or nine different lines from London at the same time. Many of the lines, which are ordinarily operated by hand, are equipped with Wheatstone instruments. These are switched in whenever the traffic for the particular line becomes too great for hand transmission. They are also much employed for temporary lines where an unusual volume is to be handled in a short time, such as in sending the enormous amount of racing and sporting news required.

The telephone service in England is not entirely under the control of the Government. The trunk lines are so controlled and operated, leaving to private companies the service in local districts. Some of these trunk lines were transferred to the Government on March 25th, 1896, by an agreement with the National Telephone Company.

In a country where the three great branches of intelligence transmission, the mail, the telegraph and the telephone, are under one management, special advantages to the people are obtained which are not given when these departments are separated. In England messages may be telephoned:

1. For transmission over the postal telegraphs and delivery as telegrams.
2. For delivery as express letters.
3. For transmission and delivery as ordinary letters.

The telephone may also be used for obtaining the services of Post Office express messengers.

As indicating the increased demands for communication between England and the Continent, the following extract from the last report of the Postmaster-General is given: "The large increase in the number of telegrams passing over the Government cables to the Continent, and in the number of conversations on the telephone circuits between London and Paris, has rendered it necessary to consider the advisability of improving the means of communication. With the cordial co-operation of the German post office, experiments were made with a view to improving the carrying capacity of the cables to Germany by the method of duplex working, which has been employed with success on some of the Anglo-French cables; but, owing to the greater length of the Anglo-German cables the results obtained were not sufficiently successful to justify the adoption of the system for practical working. Arrangements have now been made for the laying of three additional cables to the Continent, two to France, and one to Germany. These cables, each of which will contain four conductors, will afford a much-needed relief to the traffic; and it is expected that this new cable to Germany will prove suitable for duplex working."

A YEAR'S BOILER EXPLOSIONS.

When the Boiler Explosions Act came into force some years ago the Board of Trade reports on explosions were looked on by experienced men as very amusing documents. "Iron bound in red tape" might have been humorously applied to these reports and to the inspectors responsible for them. How men supposed to have experience of steam boilers could make such reports was a matter that puzzled all of us, and it does not appear that the annual report—the 15th—is much better than of old. In the 12 months the Board of Trade rakes together 80 explosions, causing 27 deaths and 75 injured, a reduction on the average of the whole 15 years, though very near the average. Great Britain possesses the best record, we should imagine, but our allowable pressures are low, and the marvel is that explosions in the United States, where pressures are so very liberal, are not far greater than they are. Only 23 explosions out of the 80 were held to require formal investigation. We must add that very paltry matters constitute a boiler explosion in the eyes of the Board of Trade. We do not think they have included broken glass water-gauges, but they came very close to this and included blown fusible plugs.

Looking through the list only 12 explosions appear to be attributable to ignorance or neglect of attendants, which would seem a powerful argument against the folly of licensing attendants by examination. In this day we are examined to death. Educate—by all means educate—but do not shut out plain horse-sense as the Americans term it by examining. As well examine a sea captain in drawing-room manners because he dines with ladies at the saloon table as examine a boiler attendant to three places of decimals.

Steam pipes, both of copper and cast-iron, continue to give way. We cannot understand why copper should still carry so much credit. Either brazed or solid it does not seem so very reliable. The report advocates lap-welded wrought-iron pipe. It is advocated to hoop them or wire them when of copper. The *Engineer* would hoop or wire all pipes say at 2 inches intervals. If a seam opened it could not be longer than 2 inches. Pipes which burst seem

* Abstract of a report to the Postmaster-General of the United States, read before the Franklin Institute, January 19th, 1898, and published in the *Electrical World*.

so readily to tear for some feet and let out huge volumes of steam. A 2-inch hole gives the men a chance of escape and time to shut off the boiler stop valve. Why the Board of Trade should so insist on the hydraulic test is a marvel. The hydraulic test is something of a fool's test and cannot displace inspection or safeguards. Boilers tested to-day by hydraulic pressure are more than likely to pop off next day—being never strengthened by the test—often an excessive one. In New York policemen go round with a van and a pump, damaging boilers by pressure and giving safety certificates. Steam piping seems to have belonged neither to boilers nor to engines, hence the neglect to manufacture it properly and to put it in place properly with provisions against strains and against rigidity.

Steam piping ought to be as carefully laid out as the engine, and every proper provision made for its drainage. So many recorded explosions are due to that wasteful class of small vertical boilers, that we may well anticipate a considerable reduction of the now apparently irreducible annual minimum as soon as electrical power transmission has wiped out the need for small verticals. Of the 23 formal investigations there were nine of vertical boilers, three horizontal, one Rastrick, and four locomotive type. Obviously there is a field for electricity in abolishing some of the nine verticals. Next year the average will be much the same. Other nine verticals are getting ready to fill next year's bill. Doubtless one of them has gone already.

CONTRIBUTIONS TO THE THEORY OF ALTERNATING CURRENTS.*

By W. G. RHODES, M.Sc. (Vict.).

[ABSTRACT.]

This paper is divided into two parts. Part I. deals with a method of finding the steady values of alternating currents in any circuits or systems of circuits, without having to perform integrations of differential equations which may be somewhat complicated.

It is assumed, however, that the electromotive forces and electric currents can be represented as simple sine (or cosine) functions of the time.

The method consists in applying the fact that if a simple harmonic function is differentiated twice in succession the result is proportional to the original function. By the application of this principle the determination of the steady values of the currents is reduced to solving a set of simultaneous *simple* equations.

After introducing the method by solving some simple problems, it is applied to the following:—

(*a*) The determination of the equivalent resistance, R, reactance and impedance, I, of a parallel circuit of n branches, taking into account mutual induction, when each branch may contain resistance, capacity, and self-induction.

The result is written

$$R = \frac{A_0 C}{C^2 + p^2 B^2}, \qquad L = \frac{A_0 B}{C^2 + p^2 B^2}, \qquad I = \frac{A_0}{\sqrt{C^2 + p^2 B^2}},$$

L being the equivalent self-induction, where A_0, C, B are certain functions of the resistances, self-inductions, capacities, and mutual inductions of the several circuits.

(*b*) The determination of the currents in the n circuits of an air core transformer having one primary coil and $n - 1$ secondary coils.

In addition to solving the problem, the conditions for resonance in the primary circuit are obtained and discussed, and special attention is given to the case of a transformer having only one secondary coil.

(*c*) The determination of the outputs of n alternators working in parallel on a non-inductive external circuit.

PART II.

This part is devoted to the consideration of the effects of higher harmonics in E.M.Fs. and currents on the values of the impedances and reactances of circuits.

The problems considered in Part I. are again discussed on the assumption that the impressed potential difference is of the form

$$E = E_1 \sin(p t - \theta_1) + E_2 \sin(2 p t - \theta_2) + \ldots + E_m \sin(m p t - \theta_m).$$

It is also shown that periodic E.M.Fs. and corresponding currents can in all cases be represented by simple sine curves having the same root mean square values, and suitable phase positions depending on the time constants of the circuits and on the periodicities of the harmonics present.

ANTHRACITE TESTS.

L'Industrie Electrique reports some tests made at the central station in the Place Clichy, Paris.

Numerous tests of all kinds of fuel have already been made with a view to smoke prevention. Coke has been tried and abandoned, both because of high price, and because its acid fumes damaged the tubes of the boilers. A municipal commission, which was appointed to consider the subject, has not yet rendered a report. Recently, however, M. A. Lalance has communicated to the Société Industrielle de Mulhouse, certain results obtained with English anthracite at the station in the Place Clichy. He had previously tried the Langer smoke preventer, so much used in Austria, and had furnished six boilers with this apparatus, using a coal named St. Charles from the Charleroi basin, which when considerably dampened, gave but little smoke, and no further complaints were made, but the mechanism necessary was delicate, and wear was so rapid as to necessitate regulation every second or third day. Searching for other and better means, he heard of the use of anthracite in London and arranged two boilers with grates of Richard's type, perforated with conical holes, and with a draught aided by three steam blowers in each closed hearth-pit. These grates are, in fact, simply perforated plates, and enable fine anthracite to be burned. The changes necessary to be made to a boiler are trifling. The fire thickness should be 3 to 4 centimetres. It is found easy to maintain pressure by draught regulation. Cardiff anthracite is described as burning quite smokelessly, and the management of the fires is easy, as with coal, and no dust is made.

The tests made by M. Heckel were for the purpose of seeing whether the numerous advantages of the coal were in any way counterbalanced in cost. The tests extended from April 5th to 16th last, and the arrangement of the plant was such as to permit either of two generators of 350 kw. each to be driven with steam from two boilers with the Langer smoke preventer, or from the two boilers burning the anthracite. No note needed to be made of water used or evaporated. So much electricity was manufactured, and so much fuel in each case was needed to do this. In fine, St. Charles coal, costing at works 28 francs per ton, was burned on the Richards grate, and anthracite, costing 34 francs per ton, was also used. The 34 francs was made up of cost, of octroi 7 francs 20 cents, and of cartage 3·50 francs.

The mean of three anthracite tests showed a fuel cost of 7,787 centimes per kw.-hour. The mean of three tests with the St. Charles coal on ordinary grates and with the smoke preventer gave a cost of 7,382 centimes per kw.-hour, and two tests with the same coal on the Richards grate with forced draught showed a mean cost of 7,458 centimes. The difference is not large, and evidently weight for weight the Cardiff coal is the better fuel, and if its price could only be reduced to 32 francs, it would stand even as to cost, and would besides have all its other advantages. Our contemporary would like to see a direct service from Cardiff to Paris, which would enable Cardiff anthracite to be not only the most pleasant fuel, but also it would show a small first cost economy.

THE DIESEL OIL ENGINE.

THE *Engineer* translates from *Zeitschrift des Vereines Deutscher Ingenieurs* a description of Diesel's oil engine or Rational Heat Motor. Diesel claims that his motor better utilises the heat supplied to it than any other motor. Thus while the best saturated steam engines give 12 per cent. efficiency, small condensing engines give only 5 per cent., which is not encouraging. This, however, is quite an unfair way of stating the case, and takes no account of the thermodynamic possibilities on which basis progress of steam engineering has not been so very hopeless. In a steam plant the boiler efficiency is 80 per cent., the engine cannot work without loss, and so a triple expansion Sulzer engine plant of 700 H.P. with steam superheated to 350° C., shows 13 per cent. mean heat efficiency, and this cannot be much extended for steam engines, for only 30 per cent. of the heat received by an engine can theoretically be turned to work.

The great drawbacks to steam are the heat lost in its generation, the low theoretical efficiency, a defect which cannot possibly be amended, the sensitive nature of steam in respect of its easy condensation, and the influence on it of its immediate surroundings as the cylinder walls.

The object of the author's research has been to improve the utilisation of heat. First, he experimented with ammonia at a large range of temperature, and found that wide temperature ranges required wide ranges for pressure also, to allow suitable expansion. This conclusion he applies to all vapours, for otherwise the vapour would be superheated at exhaust, and some portion of heat is thereby wasted. He considers it impossible, theoretically, to determine the pressures necessary to utilise the superheat, but approximates it at 50 to 60 atmospheres, and ammonia being difficult to handle at such pressures, air was tried as a simpler agent, and the same theoretical results were obtained and conclusions drawn. The air was first treated in closed vessels, with heat applied and withdrawn externally, but it became clear that the air could be compressed, and heat generated in the cylinder itself, as already performed in other internal combustion motors. In what he claims as a new process of combustion, Diesel emphasises the difference between the temperature of ignition and that of combustion. The temperature of ignition is lowered by pressure. Hitherto the temperature of combustion, which is higher than that of ignition, has been produced after ignition—by and during the process of combustion. This seems too obvious, at first sight, to gainsay, but Diesel has evolved a new system of combustion, which he calls "rational." It demands four essential conditions. First, the temperature of combustion must be produced before combustion, and independently of it, and it must be produced by the mechanical compression of air. This is seen to be in conformity with Carnot. Secondly, the air must be adiabatically compressed,

* Communicated to the Royal Society by Arthur Schuster, F.R.S. Received January 4th—Read February 10th, 1898.

and not isothermally, as demanded by Carnot, thus attaining to the temperature of combustion at 40 or 50 atmospheres—a much lower pressure than if compression be at first isothermal. By avoiding the theoretical 100 to 200 atmospheres required in the theoretical cycle, an impossible working cycle is replaced by a possible one. The air being now at the temperature of combustion, the combustible is injected into it in such manner that the heat developed by the combustion is at once converted into work. The piston, in fact, moves with the fuel ignition, and combustion adds very little or nothing to the temperature in the cylinder.

The fourth essential is somewhat contrary to preconceived ideas, which have been that excess of air for combustion should be minimised. Diesel's method, however, demands a large excess of air, but an amount carefully determined for each fuel. To carry out his system, Diesel proposed a four-cycle process, worked with three cylinders; the two outer ones being motor and combustion cylinders, and the inner one being for compression, expansion, and exhaust. The outer cranks are at 180° from the middle crank. Air is drawn into the central cylinders, partially compressed, and sent to the receiver. The two plunger pistons then draw in air on the first down stroke, and deliver it compressed to the requisite pressure on the up-stroke. On the next down stroke the combustible is admitted, and burns as the piston descends. Powdered coal has been proposed, but pulverised oil has been alone found practicable. Admission of combustible only lasts one quarter of the stroke, after which expansion occurs, exhaust then takes place into the central cylinder, the piston of which is driven down and compresses the air beneath it. On the return stroke the exhaust of this cylinder escapes to the atmosphere; thus the whole process is completed in two revolutions of three pistons or four strokes.

It is claimed that the boiler efficiency is equal to unity, the possible theoretical efficiency is from 50 to 70 per cent., and thus double that of the steam engine; the gases produced do not condense like steam—some of them must do, for they are steam—and there is no loss of heat in passages and pipes; but the mechanical efficiency must be lower, because of the high compression, and this has been argued to more than outweigh the advantages. But Krupp joined the supporters, and a 12-horse engine was made to test the question, and subsequently another and improved engine of same size, and as a result of the tests made, a 20-horse engine was next made, but it had a single cylinder only, and generally resembled an ordinary petroleum engine, being single acting and water jacketed; this latter being a source of loss not yet overcome, or apparently hoped to be overcome. This engine has undergone many tests by representations of Krupp, Sulzer, and Deutz, and by Profs. Schroter, Gutermuth, Sauvage, and others, and all seem to agree that the new motor has the highest efficiency of any motor, the efficiency being double that of steam and half as much again as other internal combustion motors.

The oil consumption is only ½ lb. per brake H.P.-hour under normal working conditions. An advantage is that no explosions are missed and combustion is complete so that no dirt collects on the internal surfaces. Nor is there ignition apparatus of any kind. The trials by Profs. Schroter and Gutermuth show a heat efficiency per I.H.P. of 34 to 35 per cent. It thus appears that Diesel's views have been confirmed, and the motor is a solitary example of an engine built to theory and living up to it, whereas in other things the theory is deduced after the practical man has shown a thing to be possible.

The exhaust gases were practically invisible and odourless, proving complete combustion, and their analysis showed for full power a mean air excess of 26 per cent., and at half power of 160 per cent.

The thermal efficiency is found to increase with lesser powers, and the economic efficiency only fluctuates between 22 and 26 per cent. The following table may be of interest. It is a summary of tests made in February last, and embraces four trials. The tests were made in Augsburg:—

Diameter of motor piston	...	9·8 inches.
Stroke " "	...	15·7 "
Diameter of air pump	...	2·7 "
Stroke " "	...	7·8 "
Calorific value of oil ...	...	18·370 B.T.U. per lb.

	Full power.		Half power.	
	I.	II.	I.	II.
Number of revolutions	171·8	154·2	154·1	158·0
I.H.P. motor cylinder...	27·85	24·77	17·71	17·72
B.H.P. " "	19·87	17·82	9·58	9·84
Mechanical efficiency per cent. ...	74·8	75·5	57·8	59·6
Oil per I.H.P. hour pounds	0·40	0·39	0·16	0·16
Oil per B.H.P. " "	0·54	0·52	0·61	0·60
Exhaust pump	404° C.	378° C.	260° C.	260° C.

THE AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION.

(*Concluded from page* 238.)

"A New Electrode for Use with the Static Machine," was presented by Dr. Lucy Hall-Brown, New York, who sent a communication on the subject. An efficient spray current could be administered by means of a wire brush on a handle, consisting of about 400 fine steel wires arranged like a small whisk.

Dr. Bergonie, of Bordeaux, France, sent three short communications, entitled:

(*a*) "A New Localising Electrode to Prevent the Diffusion of the Current."

(*b*) "Palliative Treatment of Tic Douloureux of the Face."

(*c*) "The Action of the Röntgen Rays on the Vitality and Virulence of Koch's Bacilli in Cultures."

These were translated and read by Dr. F. Schavoir, of Stamford, Conn.

The localising electrode consisted of eight or 10 narrow electrodes, connected alternately with the positive and negative poles. The current must have an extremely high intensity in order to become diffused.

In the treatment of tic douloureux, he uses a large electrode on the face, and an indifferent electrode to the dorsal region. A continuous current of 50 volts and 30 to 50 milliamperes is employed, and the periods of ascension and diminution last from seven to 10 minutes. The maximum intensity should be maintained for at least 20 minutes. As the cases had been kept under observation for several years, he could say positively that the treatment always brought relief from intense pain, and sometimes after a considerable time caused its permanent disappearance.

The author described in detail the manner in which his investigations into the action of the Röntgen rays on the tubercle bacilli had been conducted, and concluded, from his experiments, that the exposure of the culture for one hour did not destroy the virulence of the culture, but retarded its evolution, and also that the vitality of the cultures was not modified.

"Report of the Committee on Electric Light for Diagnosis and Therapy, and the Röntgen X Rays," by Dr. F. Schavoir, Stamford, Conn. With the static machine the rays produced were far more penetrating and steady, and the radiographs could be taken with a much shorter exposure than by other means; many and great improvements had been made in vacuum tubes, and that a marked increase in transparency had been secured in the fluoroscope by the substitution of barium platino cyanide for the tungstate of calcium.

The President read his address, which briefly reviewed the history of the Association, and suggested several changes which would increase the value and usefulness of the Association, and lessen the work of the executive. On motion of Dr. Charles R. Dickson, it was resolved that the Executive Council be directed to consider the suggestions contained in the President's address, and also the matter of the revision of the constitution and bye-laws; that their report be mailed to the members at least one month prior to the next meeting, and that notice of such amendments is now given.

On motion of Dr. R. J. Nunn, it was decided to hold the eighth annual meeting in the City of Buffalo, N.Y., and the second Tuesday in September and two following days were chosen as the date.

The following officers were elected for the ensuing year:—

President.—Dr. Charles R. Dickson, of Toronto, Canada.

First Vice-President.—Dr. F. Schavoir, of Stamford, Conn.

Second Vice-President.—Dr. Caleb Brown, of Sac City, Iowa.

Secretary.—Dr. John Gerin, of Auburn, N.Y.

Treasurer.—Dr. R. J. Nunn, of Savannah, Ga.

Executive Council.—Dr. Robert Newman, of New York, N.Y.; Dr. W. J. Morton, of New York, N.Y.; Dr. W. J. Herdman, of Ann Arbor, Mich.; Dr. W. T. Bishop, of Harrisburg, Pa.; Dr. G. Betton Massey, of Philadelphia, Pa.

The customary votes of thanks were passed, after which the retiring president appointed Drs. Newman and Nunn a committee to conduct the newly elected president to the chair.

Dr. Dickson, on receiving the gavel, addressed the meeting in a particularly happy vein, and requested the hearty co-operation of each member to make the meeting in Buffalo an unqualified success. He would announce his appointments of the committees on the investigation of scientific questions without unnecessary delay; he declared the meeting adjourned, to re-convene at the call of the executive council.

THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

The annual dinner of the Northern Society of Electrical Engineers was held at the Grand Hotel, Manchester, on Thursday evening. Mr. J. S. Raworth, the president of the society, occupied the chair. About 70 gentlemen were present, including Messrs. H. Edmunds, John Ely, W. P. J. Fawcus, J. Nasmith, Harry Pollitt, Alderman J. J. Meakin, T. Browett, J. F. L. Aspinall, J. H. Holmes, C. H. Wordingham, H. Lindley, H. Alabaster, Percy Rosling, J. Hardie McLean, J. Slater Lewis, E. L. Madgen, E. M. Lacey, J. B. Atherton, J. Atherton, S. V. Clirehugh, and Geo. W. Lowcock (the hon. sec. of the society).

The Chairman said letters of apology for inability to attend had been received from the Lord Mayor of Manchester (Alderman R. Gibson), Alderman Hopkinson, Mr. J. Taylor, and other gentlemen.

"The Queen" having been toasted with musical honours,

Mr. Aspinall, locomotive engineer of the L. and Y. Railway Company, in proposing "The President and the Society," said their society, he understood, was going to do something to help the locomotive engineers. The locomotive engines still existed, but they were, of course, to be superseded, and trains were to be run more conveniently than by the locomotives of to-day. He did not know how it was to be done, but that no doubt would be pointed out. Personally, he wanted to see the day when the chemist and engineer would provide a storage battery from which they could get out of it

98 per cent. of the work they put into it, and do what they did with a gas-holder. It was delightful to see the electric cabs running about in London. He did not believe in the oil motor. As had been said, "It barked like a dog, and stunk like a cat." He hoped the electric gentlemen would produce something that would get rid of the difficulties to which he had just alluded.

The PRESIDENT, in reply, said success depended entirely upon themselves. It was a very remarkable fact that a long spell of bad trade often did more good to the trade affected than a spell of prosperity. Should it happen in the spell of prosperity which he saw looming (he would rather say beaming, for he did not like the word "looming") in the distance upon them that they were not able to take it up and fulfil the demand, then the very fact that they would not be able to meet it would offer a chance to their competitors on the other side of the German and Atlantic Oceans to come in and show English customers what they could do in the very midst of Manchester. He did not think the locomotive engines would be done away with; he was of opinion that the locomotive engineer would be able to apply electricity himself, and not leave it to the electrical engineer to do it for him. He thought that the driving of railway engines by electricity was within practical range. In the black country the Pumping Commission, which did the pumping for all the pits, had held a meeting in Birmingham, and the promotors had said they could supply electric energy at 1d. per unit. That made those who had steam engines contemplate disposing of them for the new energy. It rather frightened local authorities who now supplied such energy at 8d. and 9d. per unit. Therefore, there was likely to be opposition, but they in Lancashire must reduce the cost of the electric supply. In Manchester, under certain conditions, they could get it for 1½d. per unit. (A Voice: "At Bradford for a 1d.") They, in this city, were getting down to that. With a sufficient output, there was no reason why they should not supply electric energy at 1d. per unit. They must follow the example of America. The public must be supplied with what the electrical engineers knew they wanted before they asked for it, and then a market would be created for their manufactures. It was also proposed that they should add associates to their Society in the shape of the principal cotton spinners and machinery manufacturers of the country, in order that they might put to practical use the knowledge which the Society possessed.

The toast list also included "The Retiring President (Mr. C. M. Dorman) and "The Guests," responded to by Alderman MEAKIN and Mr. NASMITH.

During the dinner, and afterwards, a glee party, under the direction of Mr. J. H. Greenwood, entertained the company with songs, glees and sketches.

THE TELEGRAPH TROUBLES.

THE CLERKS' POINT OF VIEW.

BY CHAS. H. GARLAND.

(*Continued from page* 167.)

THERE are two claims made by telegraph clerks with respect to the maximum salary. The first is that they have a right, under existing circumstances, to rise to £190 as operators and without the intervention of arbitrary and practically insurmountable barriers. The second is that this maximum should be raised, as it is insufficient under the changed conditions of service and environment. The point to which they wish it raised is £230 per year in London, and £200 in the provinces. The first claim I dealt with in my last article; the second I will now discuss.

This claim for £230 as a maximum in London is no fanciful claim, fixed with no consideration for the circumstances which regulate wages, but is a fair estimate of the value of a telegraph clerk's work at the present day. Quite apart from the question of changing environment, the work itself has so far changed that a higher degree of skill is required, there is a far greater strain on the operators, imposed by the tremendously increased mass of work to be dealt with, there is a demand for greater general intelligence and higher educational qualifications, and technical training is almost a *sine quâ non*.

Let us hear what Mr. W. H. Preece, F.R.S., the Engineer-in-Chief, has to say on this increased demand upon telegraph clerks. "The progress of telegraphy has been phenomenal. That progress has been marked by a steadily-increasing demand for the exhibition of technical knowledge and skill on the part of the artisans and operators engaged in the engineering and commercial branches of telegraphy in this country, and we are able to bear witness to the fact that those concerned have responded to this demand in a way that does them infinite credit. A standard of technical knowledge that was exceptional in the telegraph service a few years ago, is now the rule, and the time is not distant when we shall look in vain and without regret for the engineering or commercial employé who has no knowledge of the principles of the science."

The same high authority has also summarised in a form which I will not attempt to improve upon, the actual requirements. "We require that all telegraphists," he says, "at some time of their career should possess an acquaintance with the principles and the laws of electricity as applied to telegraphy and telephony, and with the mechanical construction of the apparatus that they handle. They should also comprehend the nature of faults that occur in apparatus, and evince the ability to remove these faults, and generally to secure the maintenance of the apparatus. There is no doubt that this knowledge on the part of the staff very much increases the efficiency of the service. In days gone by an immense amount of time was lost in repairing faults, owing to the fact of the only persons who could repair faults being the engineering officers, who had to be sent for; whereas now, owing to the advance of technical knowledge, the clerks are able themselves to remove slight faults at once; the result is, that delays are removed, the service has better supervision, the work is simplified, and generally the condition of our apparatus and our lines is very much better than it used to be. I should like to say this, that whatever tends to promote rapid service means increased business to the Department. There is no doubt that the number of messages that are sent by telegraph depends almost essentially on the rapidity with which they are sent and delivered, and, therefore, technical knowledge being acquired by the staff, means an addition to the revenue of the Department, and therefore justifies the Department in incurring some expenditure in improving the staff and service." These lengthly quotations are justified by the important and unimpeachable testimony they bear to the difference of requirements now, and at the time when Mr. Fawcett fixed £190 as a fair remuneration for the work of a telegraph clerk. The increase in the mass and complexity of the work is borne out by the Postmaster-General in his 41st Report. "The growth of the whole business (of the telegraphs)," he says, "since 1870 (from less than seven to more than 71 millions) has been more than 10-fold. The number of offices has increased from 2,000 to nearly 10,000. The system, including submarine cables, now consists of about 35,000 miles of line, as compared with 15,000 in 1870, and about 215,000 miles of wire, as compared with 60,000, while the number of instruments has increased from 4,000 to over 26,000." This was written in 1895, and the increase during the intervening period has kept pace. With all this development, the work and strain of the individual clerks has also vastly increased. Speaking personally, I can say that each man works immensely harder, and more continuously now, than 15 years ago, and the difficulty of remaining clear-headed and steady amid all the rush and whirl of these millions of messages, the manifold complexities of circulation, the mysterious faults and imperfections of the new and delicate apparatus, increases to an enormous extent the wear, tear, and worry of a telegraph clerk's life.

The greater amount of work turned out cannot be attributed to the improved apparatus alone. As Prof. Marshall justly observes in his "Principles of Economics" (p. 316), "The more delicate the machine's power, the greater is the judgment and carefulness which is called for from those who see after it." And from the single needle and the Morse inker of 17 years ago, to the Wheatstone transmitter, with an attainable speed of 600 words per minute, and a working speed of 400 words per minute (*vide* Postmaster-General's 41st Report), or the Delany multiplex of to-day, what an increase in this demand for judgment and carefulness. The percentage of nervous complaints demonstrates the truth of this.

What increased reward does the Department offer for this increase in the quality and quantity of the work? Does not the "model employer" set an example in this matter? Far from it. By what appears to us to be a tampering with our rights, our prospects have been actually reduced. I showed in my last paper how the obtainable maximum as an operator had been reduced from £190 to £160. What wonder, then, that telegraph clerks are discontented? and what wonder if this gnawing discontent should unconsciously affect the out-

put? I can assert truthfully that no formulated intention of restricting the output has ever gained any power among the staff, and the Postal Telegraph Clerks' Association has always discouraged such methods; but does not discontent unconsciously militate against the highest results? And under the conditions I have detailed discontent is inevitable.

It has been the custom of those opposed to us to speak glibly of the market value of our work and to assert that the present salaries—that is, the salaries with the reduced prospects of promotion—are sufficient, nay, liberal. The market rate of a man's work, as I understand it, is the point at which it is fixed by the influence of open competition, and except where powerful unions stand in the way, it is the lowest rate at which men can be induced to perform the work. In the case of a State monopoly, where there is no open competition to determine the rate, it is hard to say how this market rate is arrived at. The best method of determining a rate appears to me to be a consideration of the salary which will attract a class of men and women sufficiently well educated to come up to the best requirements of the department in the matter of efficiency, and also a salary sufficient in amount to retain the services of the most highly-skilled and efficient men in the Department. Sir Lyon Playfair, speaking before the Ridley Commission on the question of the fixing of the rates of pay for civil servants, takes practically this view. He says: "One thing that guided us very much in the terms which we offered was, that we took a great deal of evidence as to what the outside world gave for positions somewhat similar, and we found that civil servants were on these terms paid more liberally, and we could get the *élite* of the men outside who did similar work." This is undoubtedly as it should be. The rate should be such as to get and keep the *élite* of the profession in the service of the State. The *Daily News* of January 29th, 1895, said: "It is now acknowledged that to give high wages, and thus attract the pick of the market, coincides with sound policy as well as with the humane principles which ought to guide our civil administration." The Rt. Hon. James Bryce, M.P., speaking to a deputation of Aberdeen telegraph clerks on November 24th, 1897, said; "The State . . . . . ought to go upon the principle that it would not pay more than the market rate, but, that it would pay the best market rate." The present salaries and prospects held out to telegraph clerks are not consistent either with keeping the *élite* of the profession in the service of the State when opportunities of escape are offered, nor are they consistent with the principle of paying the best market rate. Nor, as the conditions of service become known, and the real nature of the prospects exposed, does the fierce competition for the places continue. Since last year's public notice of the telegraph clerks' position the number and quality of the candidates for the position has fallen immensely, as the Civil Service Commissioners' returns will show, and when the case is more fully understood there will be a still greater falling off. The *élite* of the class which would otherwise become telegraph clerks know they can put their educational abilities to a better and more profitable use.

The cable companies' scales are much higher than the Post Office scales for similar work, with the result that the best men are attracted from the postal service whenever the opportunity offers. To take only one instance: the Eastern Telegraph Company offers a scale of £50 by £12 to £204, as compared with the postal scale detailed in my last article, with its slow progress to the practically insurmountable barrier placed at £160. In Germany, where the cost and standard of living are very much lower than here, and where the service is slower and less efficient there is a maximum for the lowest class of operators of £162, and in Holland, where the same cheapness exists, a telegraph clerk can get £183 by the time he is 40 years of age.

So far are the conditions of service in cable companies and Colonial Governments superior to the postal conditions, that the advertisement of a vacancy invariably secures a rush of the very best operators. In a small office, like Newcastle, for example, 50 of its best men will apply for four positions under the Transvaal Government. Nearly the whole of the Preston staff will apply for one position in the Eastern Company, and such examples could be supplied *ad nauseam*. The result of this is, that the companies draw off many of the best men, and much of their success is to be attributed to the class of operators thus obtained.

How are the Post Office authorities meeting this increased demand on their men and the increased pay offered outside? By lowering the prospects and increasing the hardships of service; by reducing privileges and curtailing leisure. These things I believe to be not so much the fault of individual administrators as the fault of the system. An administrative system is the strongest of conservative structures, and when that system has been built up on unsound economic principles it requires more than the ordinary reforming spirit to break through it. And the principles underlying the present postal management are not those sympathetic and humane principles which should guide an administration which stands in the position of model to all other employers.

The demands of telegraph clerks are no straining after ideals. The scale which they ask is as follows:—The present scale as far as £50 per annum, and then by increments of £7 10s. to £140, thence by £10 to £230. This is for London. For the provinces the scale is lower, with a maximum of £200. It is an eminently reasonable demand. In a further paper I will defend the demand for changes in the lower portion of the scale. At present, suffice it to say that the clerks only ask that the £230 maximum should be granted under certain conditions. Upon reaching the Fawcett maximum of £190 they say: "We will be submitted to a test in theoretical and practical telegraphy and telephony, and will pass an examination in magnetism and electricity." By this means the department can assure themselves that the men who advance have kept pace with the conditions essential to the performance of the highest class of work in the most efficient manner. It is possible to stop men of bad conduct at any point in the scale, and the demand is, therefore, that men of unimpeachable character and high merit only should pass the £190 point, which Mr. Fawcett fixed for operators pure and simple. On the suggested scale a clerk would not obtain £190 until after 19 years' service, and the maximum, after having passed the tests explained above, after 23 years' service.

By adopting this scale, the Department would ensure that essential factor in efficiency—a contented body of workers; it would put itself in a position to retain the *élite* of the profession in its service; it would make its scales nearly equal to the best market rate paid for telegraph operators, and it would approximate more closely to its proper position in the first flight of employers. Surely, with the evidences one can adduce of the immense advantages to the community of an administrative policy, guided by such principles, and attaining such results, the day should not be far distant when the reasonable demands of this important body of public servants will be conceded.

(*To be continued.*)

SOME NOTES ON SINGLE-PHASE MOTORS.

By A. C. EBORALL.

(*Continued from page* 173.)

In regard to the winding, it should have as small a self-induction as possible, and is preferably of copper strip placed edgeways in the tunnels. A three-phase star-connected winding is often used, the common junction being made on the iron work of the rotor. Apart from the question of self-induction, it is generally inadvisable to use more than one conductor per slot, because, in order to comply with one of the conditions stated above, such windings are frequently very irregular. That this is so may be seen from an inspection of fig. 10, which is a six-pole rotor winding with one conductor per slot.

The simple short-circuited form of rotor described above is only used for small motors, its employment above 6 H.P. for low frequency, and 4 H.P. for high frequency motors not being attended with satisfactory results. Imagine a single-phaser with such a rotor being started up by means of any phase-splitting device. With the rotor just beginning to move, the slip is equal to the frequency of the supply cur-

rent in the stator, and the whole arrangement is practically a short-circuited transformer. Large currents circulate in rotor and stator, and the torque would be enormous if it were not for leakage. The presence of the air-gap directly promotes leakage, which means that the rotor-currents have a great lag in regard to the stator induction, and hence the motor will have very little torque, although drawing large

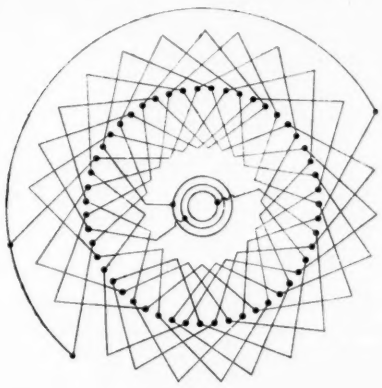


Fig. 10.

currents from the line. To sum up, then, the disadvantages connected with the employment of a simple squirrel cage rotor for motors of any size:—

1. A large wattless current is drawn from the mains, greatly disturbing the circuit on account of the voltage drop in the lines and generator, and also on account of the great demagnetising effect which it produces on the generator fields.

2. The large rotor current exerts a very powerful demagnetising effect on the stator, choking back the induction, and hence reducing the torque.

3. The rotor current being nearly wattless, it is out of phase with regard to the induction produced by the stator, and consequently the torque produced is insignificant.

4. Much of the impressed pressure may be lost in the stator coils to overcome resistance, and

5. The motor is liable to burn out.

Of course, as soon as the rotor begins to move, the rotor currents decrease, owing to the slip decreasing, and they will continue to decrease until the motor approaches its speed limit, determined by the stator poles and frequency of supply.

Thus for motors of any size, it becomes necessary to reduce these large wattless currents, both for the sake of the supply system, and to secure effective starting of the motor. The best way of decreasing the wattless current in amount, and also of bringing it more into phase, is to put a non-inductive resistance in series with the short-circuited part at starting, cutting it out as the rotor runs up to speed. This means that the short-circuited part must be wound with a regular winding, its ends being connected to slip-rings on the shaft, as mentioned above—or the ends may be connected to a resistance placed in the body of the rotor, which may be short-circuited by an external device when the rotor has got up speed.

The former plan of having the resistance exterior to the motor is on the whole preferable to the latter, as it allows the resistance to be varied, and gradually cut out, which does not disturb the circuit so much.

The resistance for this purpose must be as non-inductive as possible; if not, it may still further increase the lag. A three-phase winding is always employed on the rotor, this having the minimum of dead points, and the rotor resistance is generally star-connected, to correspond to it.

This insertion of a non-inductive resistance into the rotor is very effective. It cuts down the current in amount, and therefore limits the demagnetising effect, and at the same time this rotor current is brought more into phase (and hence the stator current also), and as a result a greatly increased torque is produced. The other harmful effects enumerated before are in consequence either greatly reduced, or obviated altogether.

Assuming the motor to be started with two currents o frequency, n, and differing 90° in phase, the *starting* torque is

$$\frac{2\,n\,\mathrm{K}\cos\phi}{\text{Rotor impedance}},$$

where ϕ is the lag in the rotor bars, and K a constant depending on the strength of the magnetic field, and on the winding of the rotor.

$$\text{As } \cos\phi = \frac{\mathrm{R}}{\sqrt{\mathrm{R}^2 + 4\,\pi^2\,n^2\,\mathrm{L}^2}} \qquad \text{(Fig. 6)}$$

the expression for the starting torque becomes

$$\frac{2\,\pi\,\mathrm{K}\,\mathrm{R}}{\mathrm{R}^2 + 4\,\pi^2\,n^2\,\mathrm{L}^2},$$

which is a maximum when $2\,\pi\,n\,\mathrm{L} = \mathrm{R}$.

Hence to get the best results, the value of the starting resistance plus the rotor resistance should be equal to $2\,\pi\,n\,\mathrm{L}$ ohms, and should be capable of being decreased as n decreases. Single-phasers are never started with two currents differing 90° in phase, and hence in practice it is usual to make the value of the starting resistance somewhat less than this.

The effect of resistance in the short-circuited part of a single-phase motor supplies the reason for several points of construction that might otherwise not appear. When describing the construction of rotors with simple short-circuited bar-winding, it was stated that the rings at the ends are made of considerably smaller section than the total section of the active bars. This is simply to enable the motor to start effectively, the resistance of the copper rings, with such large currents as they would carry at starting, being quite sufficient to enable this to be done.

There is, however, another factor entering into the case. At any given load on a motor, the torque is proportional to the product of the induction in the air-gap and the current in the rotor conductors; and therefore, the impressed stator pressure being constant, the rotor must run at such a speed that the slip allows enough pressure to be generated in the bars to overcome the resistance of its conductors. The slip is really somewhat greater than this, on account of leakage and pressure drop in the stator. It therefore follows that for a given torque the slip is nearly proportional to the resistance of the rotor, and hence that the effect of giving a certain amount of resistance to the rings, and of working with high current densities, is to cause a corresponding drop in speed of the motor, and must not be carried too far. To make a motor synchronous, all that has to be done is to put a lot of copper in the rotor conductors, and what is done in practice is to use very few bars, and work with a low current density. This construction of rotor implies a "notched" field, which further contributes to a synchronous tendency. Such motors must be run up to practically synchronism before they will go in, and take a large current, their no-load current also being high, perhaps 50—60 per cent. of the full-load current. They will carry but very little overload, their power factor also being small. Such motors are very rarely asked for—their only application would seem to be for driving rectifiers. The Pollak rectifiers running at Frankfort and Zürich are driven by motors of this type built by Messrs. Brown.

(To be continued.)

REVIEWS.

Formulaire Physico-Chimique. Par Donato Tommasi. Paris: Librairie Industrielle, 30, Rue du Dragon.

This book is a compilation of 475 pages containing a vast number of data, and much practical information, useful to physicists and chemists, and, in a less degree, to engineers and manufacturers. Chapter I. treats of fusion, solidification and vaporisation; Chapter II. of the solubility of gases, and of mineral and organic solids; Chapter III. is devoted to refrigerating mixtures; Chapter IV. to the expansion of solids, liquids and gases; Chapter V. to the phenomena of capillarity; Chapter VI. to the densities of solids, liquids and gases; Chapter VII. to thermo-chemistry and the law of thermal constants; and, lastly, in Chapter VIII, information will be found on the spheroidal condition of bodies, the

dissociation of ammoniacal salts, the nascent condition of bodies, the electromotive force of the principle voltaic couples, the capacity of certain accumulators, and the composition of some varnishes, mastics and cements.

A table of great utility to the practical man in pyrometry, since it gives fixed points of temperature, at small distances apart, from 954° to 1,775° C, is that relating to the Prinsep alloys of silver with gold and platinum.

The data relative to the liquefaction of hydrogen, oxygen, nitrogen and atmospheric air are derived from the researches of Wroblewski and Olszewski. No mention is made of Prof. Dewar. The formula of Nordenskjold for the solubility of salts, in terms of their solubility at a given temperature, is quoted; but is not explained in such a way as to render it available to the non-mathematical worker. We notice that in the table giving the degree of cold produced by the mutual reaction of solids the minus sign is accidentally omitted in the case of the mixture of sodic carbonate and manganic nitrate, which is capable of lowering the temperature to − 26° C. The data given on p. 195 relative to the increased expansion of wires — excepting in the case of hard steel—when a given temperature is produced by the passage of a current, instead of by ordinary means of heating, may be useful to some of our readers. The same may be said of the table on p. 229 giving the weight, at 15° C., of one drop of various liquids, or the number of drops to 1 gramme, when 20 drops of distilled water weigh 1 gramme. The densities (or specific gravities) of alloys of lead and antimony are given on p. 240; and a knowledge of them may sometimes save the trouble of a chemical analysis.

The tables giving the percentage of real acid in solutions of hydrochloric, nitric, sulphuric, and chromic acids of given density, will be of value to the electro-chemist; but, even in this work, the mistake of omitting to state the temperatures to which the given densities are to be referred has in some cases been made. Nor, in regard to Anthon's table (p. 273) is it mentioned that the sulphuric acid, of which various proportions are to be added to 100 of water to obtain a dilute acid of a required density, must be of the very inconvenient specific gravity 1·86—inconvenient, because the density of oil of vitriol at 15° C. (59° F.) is 1·8455, whilst that of H_2SO_4 is 1·8426. Correct tables are given of the percentages of caustic potash, and soda, in solutions of various densities.

The chapter on "Thermo-chemistry" is unsatisfactory from the point of view of the electro-chemist, who may seek in vain for the heat of constitution of the compounds, such as $PbSO_4$ and PbO_2, in which he is most interested.

On p. 380 is given a table of the capacity in ampere-hours of 1 kilogramme of plates in various accumulators. For the Laurent-Cely elements this is given as 9 to 10 ampere-hours; for the Dujardin, 15 to 18; for the Julien, 15 to 20; and for the Tommasi, 25 to 30.

The work ends with a description of two kinds of electrolytic cartridge which, the author states, may be advantageously substituted for gunpowder or dynamite for blasting in coal mines.

Light: Visible and Invisible. A series of lectures delivered at the Royal Institution of Great Britain, at Christmas, 1896. By Silvanus P. Thompson, D.Sc., F.R.S., M.R.I. London: Macmillan & Co., Limited, 1897.

This publication, in book form, of Prof. S. P. Thompson's Royal Institution lectures on light is well worth reading. This most fascinating, as well as the most exact of physical sciences is treated by an enthusiastic and gifted lecturer; and though the conditions of a popular lecture do not admit of exact demonstrations, and an immense subject is skimmed over in a few pages, the reader is left keenly interested, and stimulated to seek more information elsewhere. No doubt the style suffers from its lecture-room origin, and the colloquial form is occasionally irritating; but, taken as a whole, it attains its object, and may well stand with Kempe's "How to Draw a Straight Line," Vernon Boys's "Soap Bubbles," and some other volumes which owe their origin to the same source, the theatre in Albermarle Street. Prof. Thompson's method of treating geometrical optics by considering changes in the curvature of a wave surface, is more philosophical than that by considering changes in the directions of rectilinear rays, and we accept his assurance that it is of practical advantage in teaching. Unfortunately, in teaching some sciences, notably mechanics, the most philosophical course cannot conveniently be followed. The chapter on rays emitted from vacuum tubes is particularly interesting, and gives a clear and concise account of the state of knowledge at the time the lectures were delivered; but the distinctions drawn by Prof. Thompson between many different kinds of cathode rays would not, we think, be generally accepted. As is often the case in books of this kind, the appendices, in which particular points of interest are discussed in detail, are the cream of the whole.

ON SOME RECENT INVESTIGATIONS IN CONNECTION WITH THE ELECTRO-DEPOSITION OF METALS.*

By J. C. Graham.

So far as the author of this paper is aware, there has been no very satisfactory examination made into the conditions which are necessary for the rapid deposition of metals from their solutions by means of the electric current.

The experiments which are described in this paper appear to throw some light on the subject.

When an electric current is passed through a strong solution of sulphate of copper, the copper is deposited in a very perfect condition so long as the current density does not much exceed 200 to 300 amperes to the square metre. According to Donato Tommasi† the following are the figures:—

Poids déposé en grammes par heure et par $d\ m^2$.	Intensité du Courant en amp. par $d\ m^2$.	Nature du dépôt de Cuivre.
12	10·2	Très bon.
50	42·7	Sablonneux sur les bords.
124	106·	Mauvais sur tout le Contour.

And Tommasi adds, "Suivant H. Fontaine, pour bien opérer, il ne faut pas en pratique dépasser 1 ampère par décimètre carré de surface de Cathode, lorsque les anodes sont en cuivre chimiquement pur."

The deposit here spoken of appears to be the very good sort of deposit which is requisite for electrotyping and similar purposes, for it is beyond doubt that much denser currents can be used if the smoothness of the face of the deposit be not the principal object aimed at.

The author of this paper has made many inquiries of copper depositors for the purpose of ascertaining what is the maximum current density which is actually used by them in the practical deposition of copper, and has been unable to obtain any definite information. But so far as it is possible to form a judgment, the current density is not the same in all depositing trades, and very seldom exceeds about 300 amperes to the square metre of cathode surface.

The fact is, that the current density at which copper can be thrown down so as to obtain a good deposit depends very largely upon the thickness of the required deposit. A current density which would give a good deposit of $\frac{1}{1000}$th of an inch thick would give a very bad deposit $\frac{1}{30}$th of an inch thick, because every minute imperfection becomes enormously exaggerated as the process goes on. And this tendency to exaggerate original imperfections becomes much more marked as the current density is increased.

This effect, due to the time element, makes it very difficult to use exact language in speaking of the character of the deposit.

The effect of current density may be described in general terms as follows:—If the density be about 100 amperes to the square metre, the deposit is quite smooth and of a very pale salmon colour. If the density be increased, the surface, although still of a good colour, begins to get rough, and feels to the touch something like emery paper; if the density

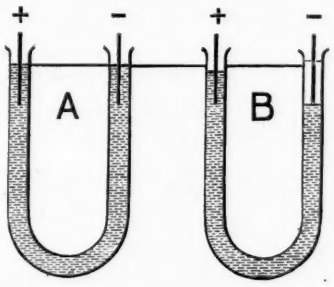
* Communicated to the Royal Society.

† "Traité Théorique et Pratique D'Electrochimie."

be further increased the deposit soon becomes discoloured, and if it be still further increased, hydrogen begins to appear in quantity on the cathode, and the copper is thrown down as a non-coherent chocolate-coloured mud.

The development of hydrogen may very well be accounted for, if it be assumed that the copper atoms in the electrolyte, which are immediately adjacent to the face of the cathode, are, in the case of dense currents, thrown down on the cathode more rapidly than they are replaced by the ordinary circulation of the electrolyte and by diffusion. If they are thrown down more rapidly than they are replaced, a time must soon come when the current has to force its way through the hydrogen molecules, which are adjacent to the cathode, and then hydrogen will be generated on the face of the cathode as well as copper.

It appeared to the author that it was not improbable that the generation of hydrogen was the most formidable obstacle in the path of rapid deposition, and that a rapid circulation



of the electrolyte over the surface of the cathode might possibly prevent the generation of hydrogen by maintaining a sufficient path for the current through copper molecules.

Some circulation is no doubt taking place in every bath where electro-deposition is in progress, and in some cases it is promoted by waving the cathodes to and fro, and probably also the atoms composing those molecules of the electrolyte which conduct the current change places and waltz round one another, according to the commonly accepted theorem, but the following experiment appears to point to the conclusion that this waltzing action is not accompanied by any movement of the waltzing atoms towards the electrodes.

A U tube was taken filled with an acidified solution of sulphate of copper, as shown in Diagram A, and a copper anode and a copper cathode were dipped into the electrolyte at the two open ends of the tube. This form of tube was adopted so as to prevent any circulation taking place. A very small current was then passed through the solution from the electrode marked + to the one marked −, and continued for two or three days. At the end of this period the electrolyte on the cathode side was in the condition shown in Diagram B. As far down as the cathode reached, all the copper in the solution had been taken out by deposition on the cathode, and immediately below the lowest point of the cathode the solution appeared to be unchanged. No change whatever had taken place round the anode so far as the eye could judge.

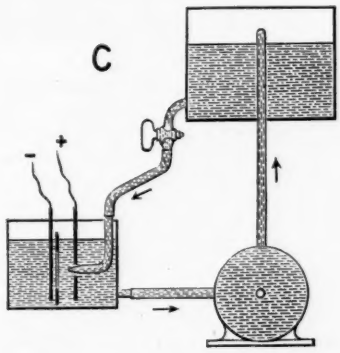
If the waltzing action had been accompanied by any movement of the atoms towards the electrodes, one would imagine that just as each atom of copper was thrown down on the cathode another atom of copper would have waltzed into its place, and consequently that no change in the electrolyte would have been expected in the neighbourhood of the cathode, but that a change might have been expected in the neighbourhood of the anode, especially if the anode had been made of some insoluble substance.

The experiment was, therefore, repeated with a lead anode substituted for a copper one. The same change was again noticed round the cathode, but no change was noticed round the anode, which could be observed by the eye.

The waltzing action does not, therefore, appear to have any appreciable effect in preventing the gradual exhaustion of the copper atoms on or near to the face of the cathode.

Mechanical circulation appeared, therefore, to be necessary to renew the copper atoms on the face of the cathode; and the next point which was investigated was whether the current density could be materially increased if, by means of a forced circulation, a continuous supply of copper atoms could be maintained on the face of the cathode.

To determine this, the apparatus shown in Diagram C was tried. In it the electrolyte was pumped up into a tank about



40 centimetres above the level of the electrolyte in the depositing bath. From this tank it was allowed to flow down a pipe, and out at a jet (below the surface) directed against the face of the cathode.

By these means a tolerably violent circulation of the electrolyte over the face of the cathode was obtained.

(*To be continued.*)

SOMETHING TO LEARN.

Englishmen do not, as a rule, know half as much of the United States as they ought to, advantageously to themselves; but we need not pride ourselves very greatly on our ignorance on this side. There is, or appears to be, quite as much amongst Americans with regard to conditions and facts in Great Britain; and we notice this more especially in connection with the prospects of electric traction on this side.

There is, no doubt, a great deal of business to be done, but some of the American technical papers give their readers very misleading information; and it seems a pity that garbled accounts should cause unnecessary trouble and expense. For instance, if a local authority in England considers the question of municipalising the tramways, a note on the subject probably appears in some of our trans-Atlantic contemporaries, implying that the said local authority is in the market for material. Forthwith circulars and price lists—perhaps even agents or representatives—appear on the scene, only to find out that two or three years must elapse before any orders can be given; and even then that home-made material will have the preference.

A recent example of this same "want of completeness," to put it mildly, occurs in the last issue of the *Street Railway Journal*, where a table is given purporting to comprise the principal cities of the British Isles and their tramway systems. Opposite to a number of these (perhaps 20) is printed the word "None"; and amongst those towns which are accordingly to be exploited for tramways are such as Hull, Salford, Bolton, Preston, Burnley, Huddersfield, Gateshead, Leith, Rochdale, St. Helens, West Bromwich, Bury, Wigan, Hanley, Devonport, Hastings, and Barrow-in-Furness. Out of all the lot, we believe that it can only be said of one that tramways do not yet exist, so we are somewhat puzzled to imagine where on earth the *Street Railway Journal* gets its information from.

It is, however, instructive to refer to some other figures supplied by our contemporary (with which we have no occasion to quarrel), to the effect that the British Isles possess about one mile of street tramway for every 40,000 inhabitants. In the nearest equivalent American area there is one mile of tramway for every 2,400 inhabitants, and the proportion of railroads is nearly the same, being one mile to every 1,800 inhabitants in Great Britain and one to 660 in the equivalent American area. We cannot, therefore, plead that many of the American street railways (*i.e.*, interurban and suburban lines), are represented with us by ordinary railroads.

Although the list of British towns without tramways drawn up by our contemporary is not to be relied upon as perfectly accurate, there is, nevertheless, nothing for us to boast about in the matter of tramway mileage.

THE NEW LYNN INCANDESCENT LAMP.

The *Electrical World* (New York) for January 29th, contains an article on an improved incandescent lamp which is being manufactured by the Lynn Incandescent Lamp Company, Mass. The mysterious commencement of the article leads one to expect improvements and novelty of a striking order. The company, has, in the course of its business of renewing burnt out lamps of different makes, taken note of all the weak points and defects of such lamps, and as a result of this special knowledge and observation, has turned its attention to producing a lamp which should embody all the good points of the best, without their defects. As might have been expected, the new lamp is pronounced to be unequalled "in the important qualities of uniformity, long life, and maintenance of candle-power."

Passing from the general to the particular, we come to a description of some of the special features and processes employed in the construction of this lamp—a description that is likely in places to provoke a smile on the faces of those acquainted with the details of lamp manufacture.

"In the construction of its new lamp, the company does not use cellulose filaments. It believes that the 'flashed surface' on the filament is the necessary factor, and therefore uses a material of higher specific resistance than cellulose, and one which admits of the greatest possible amount of 'flashed surface.' It has been the effort of the company to meet the demand from critical consumers for a uniform, efficient and high grade lamp, equal to its renewed lamp in life and sustained candle-power. One of the principal factors of the success of the Lynn Company in the manufacture of its lamps is its method of producing high vacua. On January 4th this year, Letters Patent were issued to Mr. E. F. Dwyer, the president and manager of the company, on a process of producing high vacua, which consists, substantially, of removing the main portion of the gases contained in the lamp bulb by pumping. A current is then passed through the filament and the exhaustion continued. A 16 C.P. lamp is run at about 32 candle-power, which brings the filament to an extreme white heat and excludes all the occluded gases contained in the filament. This is a new feature of lamp factory practice, the old idea being that the lamp would be strained if run above the normal candle-power; this would be true if the lamp were finished. The blackening of the bulb of the lamp is due to the condensation of the volatile carbon given off by the filament, and also from small particles of carbon thrown off mechanically, and by burning the filament to this extremely high temperature, all of these gases are thrown off and carried away by the pumps, the whole carbon becoming one homogeneous mass.

"But going back to the method of exhausting the lamps, the gases remaining in the lamp bulbs are mainly those which were purposely added during the process of exhaustion. As the lamp cools this remaining vapour condenses upon the cooler portions as a solid, leaving an almost absolute vacuum in the bulb. . . . . An important factor of the process is a mechanical pump which rapidly produces the necessary rough exhaustion. This pump in itself will, it is said, exhaust lamps equal to a mercury pump and can be used without the chemical process, but the latter saves much time and, as stated above, gives the almost perfect result."

From this not particularly lucid description of Mr. Dwyer's method of exhaustion, it is gathered that certain chemical bodies, which are capable of producing vapour at a high temperature, are introduced into the lamps whilst raised to high incandescence and during the running of a mechanical pump; and that by reason of the almost complete condensation of the chemicals on cooling, a peculiarly high vacuum is produced. This method of procedure is not new, however, having been patented in this country by Prof. Dewar in 1893—which patent, it may be remarked, anticipates in many important respects the now largely used Malignani process of chemical exhaustion. An article discussing this point was published in the Electrical Review last May. It may, of course, well be that Mr. Dwyer uses a different chemical, or chemicals, to those proposed or used by others, which gives him superior results. If so, no claim to this effect is made. It is to the principle of the process, so far as we can understand it, that attention is called.

NEW PATENTS.

[Compiled expressly for this journal by **W. P. Thompson & Co.,** *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.]*

3,032. "Steering torpedoes electrically." W. Jamieson and J. Trotter. Dated February 7th.

3,074. "Improvements in electric bells." P. Jenisch. Dated February 7th. (*Complete.*)

3,123. "Improvements in electric switches." J. M. Anderson. Dated February 8th. (*Complete.*)

3,136. "Electrolytic treatment of sulphides." J. Swinburne. Dated February 8th.

3,192. "Improved method for the electrolytic treatment of sugar juice." E. De Pas. (La Compagnie Electro-Sucriere, France.) Dated February 8th.

3,193. "Process for the electrolytic treatment of sugar juice." E. De Pas. (La Compagnie Electro-Sucriere, France.) Dated February 8th.

3,198. "Improvements in the manufacture of carbons for electrical purposes." C. L. Saunders. Dated February 8th.

3,204. "Improvements in electric arc lamps." C. A. Vigreux and L. V. Brillie. Dated February 8th.

3,207. "An improved guide for the carbon holder of an electric arc lamp." S. Bergmann. Dated February 8th.

3,209. "Improvements in electrical signalling apparatus." H. G. Leopold. Dated February 8th.

3,218. "Improvements in electric motors and dynamo-electric machines." H. H. Lake. (E. Cantono, Italy.) Dated February 8th.

3,219. "Improvements in electrical measuring instruments." A. C. Heap. Dated February 8th.

3,258. "New process for manufacturing objects, and specially cases for electric accumulators in unbreakable celluloid." E. Marckwald. Dated February 9th.

3,259. "Improvements in the construction of apparatus for producing and receiving Hertzian electric waves." E. Ducretet. Dated February 9th. (*Complete.*)

3,278. "Improvements in, or connected with, indicating electrically the changes of market prices of goods and other data." H. R. Meyer. Dated February 9th.

3,285. "Improvements in and connected with plates for electrical storage batteries." R. Kennedy. Dated February 9th.

3,313. "Improvements in electric motors." P. Iserloth. Dated February 9th. (*Complete.*)

3,316. "Improvements in a self-restoring annunciator, more particularly suitable for employment in connection with telephone switchboards." J. E. Kingsbury. (The Western Electric Company, United States.) Dated February 9th. (*Complete.*)

3,367 "Improvements in the production of acetylene light by electrolysis." D. D'Arbel. Dated February 10th. (*Complete.*)

3,368. "Improvements in secondary batteries." D. D'Arbel. Dated February 10th. (*Complete.*)

3,381. "Improvements in electric alarums." H. J. Blakeway. Dated February 10th.

3,412. "Improvements in combined fuse and switch boxes for use with high or low tension electric currents." A. J. Lawson and J. D. Dallas. Dated February 10th.

3,449. "Improvements in the electrical driving of machinery." J. R. Garner. Dated February 11th.

3,495. "Improvements in electric motors." J. S. Raworth. Dated February 11th.

3,496. "Improvements in electrical cut-out apparatus." L. Andrews. Dated February 11th.

3,501. "Improvements connected with apparatus for producing and utilising electric currents."

3,503. "Improvements in insulating materials." J. H. W. Stringfellow. Dated February 11th.

3,507. "Improvements in electric meters." Eversheds and Vignoles, Limited, and S. Eversheds. Dated February 11th.

3,514. "An electrical conducting boot or shoe for the purpose of bringing electricity from the foot into direct contact with the earth." W. Richardson. Dated February 12th.

3,555. "A combined switch and controller for electromotors." C. P. Elieson and W. S. Naylor. Dated February 12th.

3,563. "Improvements in or relating to electric arc lamps." F. Brown. Dated February 12th.

3,569. "Improvement in electrical apparatus for indicating or recording at a distance the position of an index hand or analogous movable object." A. Custodis. Dated February 12th. (*Complete.*)

3,573. "Improvements in submarine cable laying appliances." C. S. Snell. Dated February 12th.